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Is There an Optimal Level of Leverage?

The Case of Banks and Non-Bank Institutions in Europe*

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March 9, 2024

Abstract

In this paper, we evaluate whether banks and non-banks size and systemic risk are affected by their level of leverage. We implement a threshold analysis to a sample of European traditional banks and non-banks (Finance services and Real Estate Finance Services) over 2006:1-2019:4. We find that Finance Services show positive co-movements between leverage and size, independently of the level of leverage, while for traditional banks the level of leverage matters. Both banks and non-banks show positive correlation between leverage and systemic risk. During periods of crisis, SRISK measure of systemic risk allows to identify an optimal level of leverage.

Keywords: Leverage; Systemic Risk; Threshold Model; Panel Data.

J.E.L. Classification: C23, E3, G01, G15.

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1 Introduction

In this paper, we investigate the presence of positive co-movements between leverage and assets growth (leverage pro-cyclicality), and between systemic risk and fair value assets growth (systemic risk pro-cyclicality) in the European financial system. We disentangle the relative contribution of both traditional banks (TBs) and non-bank financial intermediaries (NBFIs), given their distinct business models and different levels of leverage. If leverage matters, it is also important to identify a tipping point beyond which systemic risk increases significantly affecting financial stability. To this aim, we implement the Hansen (1999) threshold analysis.

The importance of investigating the leverage and systemic risk can be explained as follows. First, in recent decades, excessive leverage, credit booms and de-leveraging episodes have been at the heart of financial instability. A decrease in the value of collateral leads to an increase in the cost of financing, thus induces financial institutions to decrease the level of leverage in the economy. The leverage pro-cyclicality of financial institutions is often known as the “financial accelerator” (Bernanke & Gertler, 1989; Kiyotaki & Moore, 1997; Bank for International Settlements, 2008, BIS, p. 1; Financial Stability Board, 2009, FSB, p. 8), which represents an important amplification mechanism in propagating financial shocks to the real economy. Second, since the sub-prime financial crisis in 2008, the shift from the “*originate-to-hold*” banking model (banks hold credit risk on their balance sheets) to an “*originate-to-distribute*” one (financial risks are traded in financial markets) has been raising concerns, in that risks are increasingly being intermediated and held outside the traditional banking system. Third, in the aftermath of both the sub-prime and the sovereign debt crisis, the prolonged period of easy financial conditions while is needed to sustain the economic recovery however also increases the development and expansion of non banking financial intermediation. In particular, NBFIs show a significant increase in risk-taking, holding almost half of global financial assets compared to 42% in 2008 (FSB, 2021b; International Monetary Fund, IMF, 2021), and become closely connected with the banking sector through direct exposures holdings of similar assets, which may have implications for the global financial stability resilience. Finally, NBFIs have become vital to the intermediation of core financial markets, such as government and corporate bonds, and are a crucial drivers of global capital flows. These flows bring benefits to recipient countries and higher returns and portfolio diversification for international investors. Recent studies show

that NBFIs may also play a role as shock absorbers by providing credit during stress episodes as bank lending to firms declines, although credit availability comes at a higher price (Adrian et al., 2012; Elliott et al., 2023).

Leverage is pro-cyclical when the balance sheet of the financial institutions co-moves (expands/contracts) with the economic cycle (Adrian & Shin, 2010). Formally, leverage (L_t), defined as the ratio between total assets (A_t) over total equity (E_t), is pro-cyclical if $\Delta L_t = f(\Delta A_t)$, and $f' > 0$. Gropp & Heider (2010) analyze a large sample of US and European banks over the period 1991-2004 to find that unobserved time invariant bank fixed-effects are important in explaining the variation of banks' capital structures. Kalemli-Ozcan et al. (2012) report that, over the period 2000-2009, both US investment and large commercial banks are pro-cyclical. Baglioni et al. (2013), using a sample of 77 European banks over 2000-2009, find that pro-cyclical leverage is reported by those banks for which the investment banking activity prevails. Damar et al. (2013), using 136 Canadian banks over the period 1994-2009, show that financial institutions that use wholesale funding report high degrees of pro-cyclicality. Aymanns & Farmer (2015), by developing an agent-based model of a multi-asset financial system, find that bank leverage management may cause leverage cycles which could affect the stability of the financial system. Beccalli et al. (2015), using 73 largest US banks over the period 2001-2010, find that US banks which are more involved in securitization have a higher pro-cyclical leverage. Avci & Çatak (2016) study the determinants of bank capital structure and the procyclical behavior of leverage for the Turkish banking sector during 2005-2014 time period. Baltzer et al. (2020), analyzing German and Europe asset markets, find that the leverage of broker-dealer is pro-cyclical and forecasts future asset returns; Cincinelli et al. (2021), using a sample of 264 Chinese financial institutions (commercial banks, finance services and real estate finance services) over 2005-2019, find that leverage pro-cyclicality mainly affects commercial banks during the global financial crisis and the monetary policy restriction.

Further, several contributions show that higher financial leverage, especially short-term leverage, induces banks to engage in illiquid and risky lending as well as in security activities which may increase systemic risk of financial institutions (Adrian & Shin, 2010; Shleifer & Vishny, 2010; Mian & Sufi, 2011; Acharya et al., 2013; Acharya & Thakor, 2016; Horváth & Wagner, 2017). Systemic risk is pro-cyclical if $\Delta Systemic Risk_t = f(\Delta A_t)$ and $f' > 0$. Following

Borio et al. (2001, p. 11), a financial indicator is said to be pro-cyclical if “*it tends to amplify business cycle fluctuations*”. Systemic risk pro-cyclicality has become a relevant research issue and several measures have been proposed to capture fluctuations of the financial cycle. In particular, we distinguish between: (i) *price-based* measures, such as global factor based on asset prices (Miranda-Agrippino & Rey, 2020); (ii) *quantity-based* measures, as the ratio of gross capital inflows to gross domestic output (Aldasoro et al., 2020); and (iii) *global liquidity* indicators (BIS, 2022). The systemic risk measures we use are the $\Delta CoVaR$ of Adrian & Brunnermeier (2016), the *SRISK* of Brownlees & Engle (2016), and the Marginal Expected Shortfall (*MES*) of Acharya et al. (2017). These measures are recognized as the most central metrics in the systemic risk literature.

This paper focuses on the leverage-asset growth nexus, and on the relationship between leverage and systemic risk in banks and non-banks financial institutions (such as FSs and REFs), for which regulators and central banks has devoted particular attention in triggering systemic risk.

An important novelty of this paper is that we implement the Hansen (1999) threshold approach to identify an equilibrium level of leverage above which financial institutions act more pro-cyclically. This is an important policy step. Previous studies limit their analyses by focusing only whether banks leverage is pro-cyclical or not, without investigating the presence of a certain level of leverage, beyond which a bank may become pro-cyclical.

Only a few papers investigate the presence of a threshold in the level of leverage. Coricelli et al. (2012) examine the relationship between leverage and productivity growth on a sample of manufacturing firms for a group of Central and Eastern European countries, employing Hansen’s (2000) threshold analysis. Dewasurendra et al. (2019) use the return-drawdown ratio and inflection point of Kelly’s cumulative return curve to compute leverage levels for banks in the US. In our work, we incorporate non-bank institutions, which have gained significance especially during the most critical financial crisis periods. In addition, we implement an econometric technique specifically designed to pinpoint the threshold at which leverage within the financial sector (including banks and non-bank institutions) becomes a matter of concern. Indeed, whether a financial entity surpasses (or falls below) this threshold can be viewed as an indicator of the sustainability of its leverage.

We conduct an extensive analysis of the (quasi-market and accounting) leverage and systemic risk pro-cyclicality using a rich dataset containing 597 European financial institutions listed over the time period 2006:1-2019:4, of which 129 TBs and 468 NBFIs (287 Finance Services, FSs, and 181 Real Estate Finance Services, REFs). We also evaluate whether the European financial system is pro-cyclical by considering the following five subperiods: “*Pre-Crisis*” (2006:1-2007:2), the “*Subprime Crisis*” (2007:3-2008:3), the “*Global Financial Crisis*” (2008:4-2010:2), the “*Sovereign Debt Crisis*” (2010:3-2012:4) and the “*Post Crisis Period*” (2013:1-2019:4).

The main empirical findings can be summarized as follows. For the entire financial system, the quasi-market leverage levels are 6.31% and 6.26%, during pre- and post- crisis, respectively, which rockets to an average of 42.36% during the subprime crisis. Accounting leverage, instead, falls during stressed market situations (namely, 4.69%, 15.58%, 14.50% during the three the financial crises) and increases to 23.34% during the first pre-crisis period. However, the optimal threshold levels of leverage show different results when we focus on NBFIs. In particular, under and beyond a certain threshold level (1.91% for FSs and 1.03% for REFs), when the leverage is measured on accounting values, both FSs and REFs are always pro-cyclical. FSs and REFs are pro-cyclical independently of any levels of leverage. In contrast, TBs become more pro-cyclical only when their accounting leverage level goes beyond a certain threshold level of 5.31%. Instead, when we consider the quasi-market leverage, only FSs remain always pro-cyclical. In addition, they become pro-cyclical when their leverage level exceeds 7.72%, only during the GFC. A possible explanation may be found in the composition of their balance sheets, which consist largely of risky assets, thus increases in leverage may correspond to increases in risk-taking. A higher pro-cyclicality for FSs may also be explained by their specific lending activities in relevant sectors such as consumer finance, auto finance, retail mortgage provision, commercial property finance, and equipment finance, where traditional banks are not active players. Another explanation relies on two arguments provided by Adrian & Shin (2010): (i) a bank is supposed to target its capital to a fixed proportion of its Value-at-Risk (VaR); (ii) market value accounting makes the value of bank assets strongly dependent on the price changes of assets traded in financial markets. Another explanation is that some vulnerabilities related to financial leverage, liquidity, and interconnectedness build up in certain segments of

the NBFIs, such as the finance services. Particular concerns arise from poor liquidity and high financial leverage. The unwinding of leveraged positions by NBFIs can be made more abrupt by the lack of market liquidity, triggering spirals of asset fire sales and investor runs amid large swings in asset prices. Because banks provide NBFIs mostly with financial leverage, interconnectedness can also become a crucial amplification channel of financial instability, able to generate spillovers to other markets, including core funding markets, as well as to other intermediaries (both banks and NBFIs), thus leading to an increase of systemic risk.

As far as the pro-cyclicality of systemic risk is concerned, overall we find that financial institutions show a pro-cyclical behavior with respect to the three measures of systemic risk ($\Delta CoVaR$, MES , and $SRISK$). For all measures of systemic risk, we find that the financial system tends to be more pro-cyclical when the quasi-market leverage is considered. In particular, only $SRISK$ allows to identify optimal threshold levels, statistically significant during both the three regimes characterized by financial crises and during tranquil period.

Our paper enriches the recent asset-pricing literature which has explored the impact of leverage on asset returns (Adrian et al., 2010, 2014; Adrian et al., 2016), and on the role of the financial sector in asset price amplification, which could in turn trigger adverse feedback loops (Adrian et al., 2022). Our paper is also related to the financial economics literature which evaluates the predictive power of systemic risk measures as early warning indicators (Danielsson et al., 2016; Giglio et al., 2016; Caporin et al., 2022; Bevilacqua et al., 2023). Finally, our work contributes to the lively debate regarding the appropriate policy tools provided by financial authorities to mitigate the pro-cyclical effects arising from leverage and market asset valuation (BIS, 2009; European Central Bank, ECB, 2021), and to enhance the understanding and the ongoing monitoring of systemic risks in NBFIs (FSB, 2021a, 2021b).

The reminder of the paper is organized as follows. Section 2 describes the data and reports some summary statistics of the variables. In Section 3, we present the methodology to testing for an optimal level of leverage. In Section 4, we investigate the presence of leverage and systemic risk pro-cyclicality by applying Granger causality in heterogeneous panels. Section 5 concludes and provides some policy implications.

2 Data

In this section, we describe the sample composition, the financial institutions characteristics (*Section 2.1*), and some stylized facts regarding the systemic risk measures for the European financial system (*Section 2.2*).

2.1 Data description

Our empirical analysis focuses on a panel of 597 European listed financial institutions between 2005:4 and 2019:4 time period. The dataset contains both 129 Traditional Banks (TBs), 287 Finance Services (FSs) and 181 Real Estate Finance Services (REFs). The data source is *Refinitiv*. FSs and REFs entities belong to the non-bank financial intermediation sector defined as a “*broad measure of all non-bank financial entities, composed of all financial institutions that are not central banks, banks or public financial institutions*” (FSB, 2021b, p.3). The main reason for considering different categories of financial institutions is that there are relevant specific features in the underlying business model that are likely to affect their leverage and systemic risk pro-cyclicality. FSs provide a valuable alternative financing way for many firms and households, fostering competition in the supply of financing and supporting economic activity, while REFs play an important role in the economy and its developments may have a material influence on the financial system.

Table 1 reports firm-level characteristics for the balance sheets of all the financial institutions belonging to our sample. $Size_{i,t}$ is natural logarithm of the total assets of financial institution i at quarter t ; $\Delta Size_{i,t}$ is the quarterly growth of total assets of financial institution i at quarter t ; $Quasi-Market Leverage_{i,t}$ is the quasi-market leverage ratio (see Acharya et al., 2017) defined as the market value of assets (market capitalization of equity plus debt) over market capitalization (equal to the share price multiplied by the number of shares outstanding) of financial institution i at quarter t ; $Accounting Leverage_{i,t}$ is the total assets to equity ratio of financial institution i at quarter t . These ratio are proxies for the level of solvency of a financial institution. For both leverage ratios, we calculate their quarterly growth rate. We consider both accounting and market leverage for the following motivations. First, both central banks and regulators focus on book values. Secondly, market values are also important to consider, especially regarding their relationship with book leverage over the cycle. Market capitalization of a financial institution

reflects the market value of the equity holders' stake, and hence an assessment by market participants of the creditworthiness of the financial institution as a borrower.

[INSERT SOMEWHERE HERE TABLE 1]

In relation to the *Size*, banks are, on average, 87 time larger than non banks financial intermediaries (64 and 206 times larger than FSs and REFs respectively). The quarterly asset growth of banks is larger relatively to FSs and REFS, and they have higher *Leverage*, both at market and accounting values, confirming that non banks financial intermediaries are associated with lower leverage ratios. However, there are some notable differences among financial institutions. The market leverage of FSs (8.37%) is lower relative to REFs (15.56%). In addition, TBs and FSs show 0.64% and 0.26%, respectively, while REFSs have a negative market leverage growth, -0.44%.

We also investigate the data over five sub-periods, namely: “*Pre-Crisis*” (2006:1-2007:2), the “*Subprime Crisis*” (2007:3-2008:3), the “*Global Financial Crisis*” (2008:4-2010:2), the “*Sovereign Debt Crisis*” (2010:3-2012:4) and the “*Post Crisis Period*” (2013:1-2019:4). By inspection Table 2, it is possible to have an idea of the quarterly summary statistics for the financial institutions characteristics over the five sub-periods. We notice that the European financial system grew by 19.27% during 2006-2019 time period. However, investigating each kind of financial intermediaries, we find that REFs grew by 68.74%, FSs by 35.42%, and TBs by 21.15%. Focusing on the *Leverage* ratio, we notice a different path between market and accounting values. In particular, accounting leverage seems to make clear how the leverage trend of FSs and REFs increased during the sub prime and global financial crises, in contrast to TBs. After the sovereign debt crisis, leverage ratio shows a remarkable decline for all the financial entities (see Figure1). The decline is particularly emphasized for the banking sector where banks, in response to regulatory requirements, enhanced their resilience to adverse shocks through a substantial strengthening of capital positions (i.e., Basel III capital standards).

[INSERT SOMEWHERE HERE TABLE 2]

Looking at the market leverage, for all entities, it increases after the onset of sub prime crisis and decline sharply after the global financial crisis till the outbreak of sovereign debt crisis. The market leverage for non banks financial intermediaries has registered a rapid growth, from

12.62% to 14.46% for REFs and from 6.44% to 8.52% for FSs, between the sub-prime crisis to the post-crisis sub periods. From Figure 1, we also notice a fundamental difference between accounting leverage for FSs and REFs relative to TBs: book leverage is low during downturns (especially the sub prime crisis) and high during tranquil period (post crisis sub period). This result is explained by the fact that while financial institutions can actively manage the behaviour of accounting leverage, market leverage is determined primarily by market forces. As for market leverage, it is high during downturn for all financial institutions confirming that, on one hand is determined primarily by market forces, and on the other hand its countercyclicality comes from the fact that more of the value of the financial institution is “in the hands” of the debt holders during financial turmoil (Adrian et al., 2016). Starting from 2013, we observe a decline in market and accounting leverage for each kind of financial institutions, especially for TBs and REFs, confirming the close interplay between the real estate sector, funding providers and other economic sectors, particularly the banking sector, and the strong feedback loops between the financial system and the real economy, reinforcing any negative developments.

[INSERT SOMEWHERE HERE FIGURE 1]

In order to get some preliminary evidence on the relationship between total asset and leverage growth, we perform a graphical analysis by reporting scatter charts of the rate of change between time t and $t+1$ of total assets and leverage. Figure 2 shows the relationship between leverage (market and accounting values), and total assets for the European financial system as a whole. Scatter plots for each financial institution are reported in Figure B1, in Appendix B. The comparison of the scatter charts shows that, within the European financial system, the relationship between leverage and assets growth is positive, indicating that leverage is pro cyclical.

[INSERT SOMEWHERE HERE FIGURE 2]

2.2 Systemic risk in the European Financial System

Table 3 reports the summary statistics of our three measures of systemic risk. We find that $\Delta CoVaR$ ranges from a low of -9.49% to a high of 17.5%, MES ranges from a low of -7.91% to a high of 38.14%, and the $SRISK$ ranges from a low of -10,857.50 (EUR thousands) to a

high of 8,421,818.00. For all the systemic risk measures ($\Delta CoVaR$, MES , $SRISK$), on average, traditional banks show a higher systemic risk (1.76%, 1.3%, EUR 461,094.02) in comparison to FSs (0.8%, 0.59%, EUR 5,365.96) and REFs (0.84%, 0.64%, EUR 3,895.21). To avoid outliers, we winsorized $\Delta CoVaR$, MES and $SRISK$ at 1st and 99th percentiles.

[INSERT SOMEWHERE HERE TABLE 3]

We estimate the individual institutions systemic risk measures over the period January 2006 to December 2019. Financial institutions' stock prices and state variables are taken from *Refinitiv* database. In our analysis, we take the positive value of $\Delta CoVaR$ and MES and therefore in all tables positive coefficients indicate increases of systemic risk, and viceversa.

Figure 3 shows the fluctuations of the three measures of systemic risk showing a significant peak during the financial crisis. The contribution to systemic risk by all financial intermediaries was low to non-existent until 2007 when the mean of $\Delta CoVaR$, MES , and $SRISK$ increased dramatically. Systemic events, which took place since September 2008 (e.g., the Lehman bankruptcy and the rescue of AIG), show a relevant impact on the real economy. The distress of several financial institutions determined distress to the full financial system which could not function normally. After the crisis, the average of $\Delta CoVaR$, MES , and $SRISK$ for all financial intermediaries decreased again showing that the average contribution of intermediaries to systemic risk was again limited. We also conduct a comparison among TBs, FSs, and REFs. Figure 4 shows the three measures of systemic risk for each financial intermediaries. It is interesting to stress that the major contribution to systemic risk comes from the banking and real estate sectors. Notably, $SRISK$ reports REFs as the major financial intermediaries which contribute to systemic risk.

[INSERT SOMEWHERE HERE FIGURES 3 AND 4]

Likewise, the scatter plots in Figure 5 report the relationship between systemic risk' measures ($\Delta CoVaR$, MES , $SRISK$) and the size growth both for the entire European financial system. The figures report a positive relationship with the assets growth, indicating that each systemic risk measures is pro-cyclical.

[INSERT SOMEWHERE HERE FIGURE 5]

3 Leverage and systemic risk pro-cyclicality using a threshold analysis

We implement the Hansen (1999) approach, that we briefly introduce in *Section 3.1*, to study potential asymmetric effects in the level of leverage. The threshold analysis for leverage pro-cyclicality is reported in *Section 3.2*.

3.1 Estimating and Testing Threshold Effects

The Hansen (1999) approach allows to estimate and test threshold effects in case of static panels with fixed effects and homogeneous slopes, where the time dimension (T) is short and the cross-section dimension (N) is large. We begin our econometric analysis with the following Equation:

$$y_{i,t} = \beta_0 + \beta_1 x_{i,t} I(q_{i,t-1} \leq \gamma) + \beta_2 x_{i,t} I(q_{i,t-1} > \gamma) + \varepsilon_{i,t} \quad (1)$$

where $I(\cdot)$ is a function indicator that takes the value 1 if the contents are enclosed in parentheses proves to be true and 0 in other cases; $q_{i,t-1}$ is the default threshold variable endogenously estimated. Based on Equation (1), we estimate the following model:

$$\begin{aligned} \Delta Leverage_{i,t} = & \beta_0 + \beta_1 \Delta Size_{i,t} (Leverage_{i,t-1} \leq \gamma) + \beta_2 \Delta Size_{i,t} (Leverage_{i,t-1} > \gamma) + \\ & + \sum_{i=1}^{597} Financial\ Institutions_i + \sum_{t=2006:1}^{2019:4} Time_t + \varepsilon_{i,t} \end{aligned} \quad (2)$$

where $\Delta Leverage_{i,t}$ is the “*quasi-market leverage*” ratio growth defined as the market value of assets (market capitalization of equity plus debt) over market capitalization (equal to the share price multiplied by the number of shares outstanding) for financial institution i at quarter t ; $\Delta Size_{i,t}$ is the size growth (as natural logarithm of total assets) for financial institution i at quarter t . As an alternative to “*quasi-market leverage*” ratio, we consider “*accounting leverage*” defined as the ratio between total asset and total equity without considering assets valued at fair value; *Financial Institutions* is a set of dummies capturing fixed effects for each institution TBs, FSs, and REFs; *Time* is a set of dummies capturing fixed effects for each quarter. $Leverage_{i,t-1}$ captures financial institutions’ reaction to the leverage level in the previous quarter ($t-1$).

The threshold variable, γ , is set to be the last period' leverage ratio level. When financial institutions increase their leverage (above the threshold value γ), they may become more procyclical, and it is given by β_2 rather than β_1 . The model allows the threshold value to be chosen endogenously. We also investigate whether a higher leverage procyclicality may affect the stability of the financial system.

$$\begin{aligned} \Delta Systemic Risk_{i,t} = & \beta_0 + \beta_1 \Delta Size_{i,t} (Leverage_{i,t-1} \leq \gamma) + \beta_2 \Delta Size_{i,t} (Leverage_{i,t-1} > \gamma) + \\ & + \sum_{i=1}^{597} Financial Institutions_i + \sum_{t=2006:1}^{2019:4} Time_t + \varepsilon_{i,t} \end{aligned} \quad (3)$$

where *Systemic Risk*_{*i,t*} allows for the three systemic risk indicators: (i) the $\Delta CoVaR$ of Adrian & Brunnermeier (2016); (ii) the *SRISK* of Brownlees & Engle (2016); (iii) and the Marginal Expected Shortfall (*MES*) of Acharya et al. (2017)¹.

3.2 Empirical Results

Table 4 reports the results using the threshold analysis when the dependent variable is the $\Delta Quasi-Market Leverage$. Over the full time period and for the entire financial system, the optimal threshold level is 5.31%. Figure 6 shows that the optimal quasi-market leverage (blue line) levels are 6.31% and 6.26%, during pre- and post- crisis but rocketed to an average of 42.36% in the regime characterized by the subprime crisis, which could be considered an upswing in the leverage cycle. The results confirm that the quasi-market leverage is high during downturn for all financial institutions confirming that (i) is determined primarily by market forces, and that (ii) its countercyclicality comes from the fact that more of the value of the financial institution is “*in the hands*” of the debt holders during financial turmoil (Adrian et al., 2016, p. 7).

[INSERT SOMEWHERE HERE FIGURE 6 AND TABLE 4]

Table 5 reports the results when the dependent variable is the $\Delta Accounting Leverage$. We note that above a certain threshold level $\gamma=13.61\%$, it becomes more procyclical, and that it changes depending on the different sub-period considered. A possible explanation is related to

¹Appendix A reports a detailed description for each systemic risk measure.

the leverage cycle. According to Fostel & Geanakoplos (2008), leverage falls during stressed market situations and builds up prior to a financial crisis. We note that, for the entire financial system, threshold optimal accounting leverage (orange line) levels are 23.34% in the first pre-crisis period and 4.69%, 15.58%, 14.50% during the three regimes characterized by the financial crisis.

However, the optimal threshold levels of leverage show different results when we focus on NBFIs. In particular, under and beyond a certain threshold level (1.91% for FSs and 1.03% for REFs), when the leverage is measured on accounting values, both FSs and REFs are always pro-cyclical (Specification [i]). FSs and REFs are pro-cyclical independently to any levels of leverage. In contrast, TBs become more pro-cyclical only when their accounting leverage level goes beyond a certain threshold level of 5.31%. Instead, when we consider the “*quasi-market leverage*”, only FSs remain always pro-cyclical. In addition, they become pro-cyclical when their leverage level exceeds 7.72%, only during the GFC. A possible explanation may be found in the composition of their balance sheets, which consist largely of risky assets, while a substantial portion of the liability side consists of short-term and collateralised borrowing. Increases in leverage may correspond to increases in risk-taking. Moreover, credits provided by FSs are often securitized, with demand depending on credit risk and yields offered. They may also be subject to rollover risk in the form of early amortization triggers, which may be particularly acute during periods of market stress, when collateral values fall and haircuts increase on counterparty risk concerns. In addition, very low rates and asset price volatility, since the GFC, have incentivized financial institutions and investors to use financial leverage to boost expected returns.

Another explanation is related to the FSs specialization in areas such as consumer finance, auto finance, retail mortgage provision, commercial property finance, and equipment finance. Thus, since FSs are the non-bank intermediaries most like banks in terms of their business models and scope of activities, they tend to either compete with banks or offer services in niche markets where banks are not active players, and often concentrate their lending activities in specific sectors due, in part, to expertise. As a result of such specialisation, FSs may become highly exposed to cyclical sectors (FSB, 2021b).

Table 6 reports the results when the dependent variables are the growth in each systemic

risk measure: $\Delta\Delta CoVaR$, ΔMES , and $\Delta SRISK$. For all measures of systemic risk, we find that both TBs and NBFIs are systemic risk pro-cyclical, independently to their level of leverage. In particular, only *SRISK* allows to identify optimal threshold levels, statistically significant, during the three regimes characterized by the financial crisis and during tranquil period as well².

[INSERT SOMEWHERE HERE TABLES 5 AND 6]

4 Causality Analysis in Size, Leverage and Systemic Risk

In this section, we investigate the presence of leverage and systemic risk pro-cyclicality in the European financial system by applying Granger causality in heterogeneous panels. To this aim, we implement the Dumitrescu & Hurlin (2012) test, who propose an extension of the Granger (1969) designed to test causality in panel data. This test assumes all coefficients to vary across sections. In addition, the authors by using Monte Carlo experiments show that this test fits well enough to a relatively short span of data even in the existence of cross-sectional dependence. The test is valid both for $T > N$ and $T < N$, for unbalanced, and heterogeneous panels.

4.1 Granger Causality in Panel Data: A Summary

In what follows, we briefly introduce the procedure. Let us consider the following linear model:

$$y_{i,t} = \alpha_i + \sum_{k=1}^K \gamma_i^{(k)} y_{i,t-k} + \sum_{k=1}^K \beta_i^{(k)} x_{i,t-k} + \varepsilon_{i,t} \quad (4)$$

with y and x two stationary variables observed for N individuals on T periods and $K \in \mathbb{N}^*$ and $\beta_i = (\beta_i^{(1)}, \dots, \beta_i^{(K)})'$. The individual effects α_i are supposed to be fixed in the time dimension. The lag orders K are identical for all cross-section units of the panel and the panel is balanced. It is a fixed coefficient model with fixed individual effects. The null hypothesis of homogeneous non causality is defined as:

$$H_0 : \beta_i = 0 \quad \forall i = 1, \dots, N \quad (5)$$

²We also replicate our analyses after excluding traditional banks, finance services and real estate finance services belonging to the so-called PIIGS (Portugal, Ireland, Italy, Greece and Spain) countries. The results confirm the presence of pro-cyclicality for financial institutions not belonging to PIIGS countries and are available upon request.

with $\beta_i = (\beta_i^{(1)}, \dots, \beta_i^{(K)})'$. Dumitrescu & Hurlin (2012)' test assumes that there can be causality for some individuals but not necessarily for all. Thus the alternative hypothesis is:

$$\begin{aligned} H_1 : \beta_i &= 0 & \forall &= 1, \dots, N_1 \\ \beta_i &\neq 0 & \forall &= N_1 + 1, N_1 + 2, \dots, N \end{aligned} \quad (6)$$

where $N_1 \in [0, N - 1]$ is unknown. If $N_1 = 0$, there is causality for all individuals in the panel. N_i must be strictly smaller than N ; otherwise, there is no causality for all individuals, and H_1 reduces to H_0 .

Dumitrescu & Hurlin (2012) propose to use the average of individual Wald statistics associated with the test of the non causality hypothesis for units $i = 1, \dots, N$. The average statistic $W_{N,T}^{HNC}$ associated with the null Homogeneous Non Causality (HCN) hypothesis is:

$$W_{N,T}^{HNC} = \frac{1}{N} \sum_{i=1}^N W_{i,T} \quad (7)$$

where $W_{i,T}$ denotes the individual Wald statistics for the i -th cross-section unit corresponding to the individual test $H_0 : \beta_i = 0$. Under the assumption that the Wald statistics are independently and identically distributed across individuals, the standardized statistic $\bar{Z}$, when $T \rightarrow \infty$ and $N \rightarrow \infty$ follows a standard normal distribution:

$$\bar{Z} = \sqrt{\frac{N}{2K}} \times (\bar{W} - K) \xrightarrow[T, N \rightarrow \infty]{} N(0, 1) \quad (8)$$

where K is a lag order selection. For a fixed T dimension with $T > 5 + 3K$, the approximated standardized statistic $\tilde{Z}$ follows a standard normal distribution:

$$\tilde{Z} = \sqrt{\frac{N}{2K} \times \frac{T - 3K - 5}{T - 2K - 3}} \times \left(\frac{T - 3K - 3}{T - 3K - 1} \times \bar{W} - K \right) \xrightarrow[T, N \rightarrow \infty]{} N(0, 1) \quad (9)$$

The test of null hypothesis is based on $\bar{Z}$ and $\tilde{Z}$. If these are larger than the standard critical values, then H_0 is rejected and the Granger causality exists. For large N and large T panels, one needs to $\bar{Z}$ can be considered, while for large N and small T datasets, $\tilde{Z}$ is favored (Dumitrescu & Hurlin, 2012).

4.2 Empirical Results

We perform the Dumitrescu & Hurlin (2012) panel causality test using the stationary representation of the variables, identified via the implementation of the (Pesaran, 2007) procedure which accounts for the presence of cross sectional dependence³.

We test for the existence of at least one casual relationship on both leverage and systemic risk pro-cyclicality. If so, we can write $\Delta Size \rightarrow \Delta Leverage$ and $\Delta Size \rightarrow \Delta \Delta CoVaR$, ΔMES , and $\Delta SRISK$, where " $\rightarrow$ " stands for "*variable x Granger cause variable y*". The analysis is conducted by considering both the full time period (2006:1-2019:4) and all financial institutions (i.e., TBs, FSs, and REFs). For leverage and systemic risk pro-cyclicality, we obtain the p -values and critical values of $\bar{Z}$ and $\tilde{Z}$.

Table 7 reports the results. There is evidence of Granger causality between $\Delta Size \rightarrow \Delta Leverage$. Regarding leverage pro-cyclicality, both market and accounting leverage turn out highly statistically significant, setting the case for leverage pro-cyclicality in the sample of European financial institutions. Therefore, we find that the active pro-cyclical management of leverage affect traditional banks, and both FSs and REFs. By including both banks and other financial intermediaries, such as FSs and REFs, for which regulators and central banks has devoted particular attention in triggering systemic risk, we shed some light on the European financial system given that its dynamic economic activity and trading activities play a dominant role in the equity markets across the European countries.

As far as the systemic risk pro-cyclicality is concerned, we find that $\Delta Size \rightarrow \Delta \Delta CoVaR$, ΔMES , and $\Delta SRISK$. An increase in the asset size leads to an increase in systemic risk. This result is in line with a large number of papers which show that systemic risk is sensitive to financial institution's size in particular large financial institutions, amongst others López-Espinosa et al. (2012), Adrian & Brunnermeier (2016), Sedunov (2016), Bostandzic & Weiß (2018), Varotto & Zhao (2018), Bellavite Pellegrini et al. (2022a, 2022b). In addition, this result confirms the hypothesis that within and outside the banking sector, the increase in leverage have a positive effect on the growth rate of systemic risk. NBFIs show a significant increase in risk-taking, holding almost half of global financial assets compared to 42% in 2008 (FSB, 2021b; International Monetary Fund, IMF, 2021), and become closely connected with the banking

³We do not report the results, which are available upon request.

sector through direct exposures holdings of similar assets, which may have implications for the global financial stability resilience. FSs clearly depends on their close dependence with the financial markets' dynamics which may be potentially trigger financial instabilities. Finally, the real estate sector, being associated with rapid growth in credit levels and increases in leverage, may have threatening implication for the stability of the financial system as a whole.

[INSERT SOMEWHERE HERE TABLE 7]

5 Conclusions and Policy Implications

In this paper, we evaluated the presence of positive co-movements between leverage and assets growth (leverage pro-cyclical), and between systemic risk and fair value assets growth (systemic risk pro-cyclical) where systemic risk is measured via $\Delta CoVaR$, MES , $SRISK$. We implemented the Hansen (1999) threshold analysis to identify the optimal level of leverage. We conducted an extensive panel data analysis using a sample of 597 European financial institutions, continuously listed over the time period 2006:1-2019:4, of which 129 TBs and 468 NBFIs (287 FSs and 181 REFs).

The Hansen (1999) threshold analysis allowed us to identify different levels of leverage both for the full period and different regimes, and both for the entire financial system and each type of financial entity. Over the full period and for the entire financial system, the optimal threshold level, for quasi-market leverage, was 5.31%, 6.31% and 6.26%, during pre- and post- crisis, while it rocketed to an average of 42.36% in the regime characterized by the subprime crisis. However, the optimal threshold levels of leverage showed different results when we focused on NBFIs. In particular, under and beyond a certain threshold level (1.91% for FSs and 1.03% for REFs), when the leverage is measured on accounting values, both FSs and REFs are always pro-cyclical. FSs and REFs are pro-cyclical independently to any levels of leverage. In contrast, TBs become more pro-cyclical only when their accounting leverage level goes beyond a certain threshold level of 5.31%. Instead, when we considered the quasi-market leverage, only FSs remain always pro-cyclical. In addition, they become pro-cyclical when their leverage level exceeds 7.72%, only during the GFC.

As far as the pro-cyclical of systemic risk is concerned, we found that financial institutions show a pro-cyclical behavior with respect to the three measures of systemic risk ($\Delta CoVaR$,

MES, and *SRISK*), and that the financial system tends to be more pro-cyclical when the quasi-market leverage is considered. In particular, only *SRISK* allows to identify optimal threshold levels, statistically significant, during the three regimes characterized by the financial crisis and during tranquil period as well.

The main findings in this study have important policy implications. First, there is the need to monitor systemic risk in NBFIs by enhancing the existing analytical tools and developing new ones, such as (i) indicators of vulnerabilities in individual NBFIs associated with particular activities like segment-specific and system-wide interconnectedness maps; (ii) stress tests to assess the ability of market participants to respond to a shock and to analyze common vulnerabilities and spillovers across markets. Second, in presence of rapid credit growth and when asset prices increase, the financial authorities should find appropriate to increase capital requirements in order to maintain system wide stability; in contrast, financial institutions management have less incentives to take corrective actions, thus leading to some distortions in incentives and responsibilities between financial authorities and private sectors participants. Finally, since NBFIs sector is wide and heterogeneous, other types of policies should be related to enhance the resilience of liquidity supply in period of stress and preparedness of authorities and market participants. Regarding the latter, it becomes also important to consider the potential role of public sector by reducing the need for extraordinary central bank interventions.

There are some interesting developments for future research. It will be important to use the leverage of banks or NBFIs as a state variable to evaluate whether and how pro-cyclicality of systemic risk varies across states using smooth transition regressions may help to better understanding the raising of new vulnerabilities within the a financial system (van Dijk et al., 2002; Christiansen et al., 2011). In addition, NBFIs go beyond the FSs and REFs considered in this paper and thus it will be interesting to evaluate the impact of other NBFIs on leverage and systemic risk pro-cyclicality when a richer dataset is available. Finally, it would be interesting to evaluate the pro-cyclicality of leverage for non-profit financial institutions, such as credit unions and microfinance institutions, given their crucial roles in promoting economic development and addressing social and economic inequalities in various communities. The issues above are part of an ongoing research project.

References

- Acharya, V. V., Pedersen, L. H., Philippon, T., & Richardson, M. (2017). Measuring systemic risk. *The Review of Financial Studies*, 30(1), 2–47.
- Acharya, V. V., Schnabl, P., & Suarez, G. (2013). Securitization without risk transfer. *Journal of Financial Economics*, 107(3), 515–536.
- Acharya, V. V., & Thakor, A. V. (2016). The dark side of liquidity creation: Leverage and systemic risk. *Journal of Financial Intermediation*, 28, 4–21.
- Adrian, T., Borowiecki, K. J., & Tepper, A. (2022). A leverage-based measure of financial stability. *Journal of Financial Intermediation*, 51, 100907.
- Adrian, T., Boyarchenko, N., & Shin, H. S. (2016). On the scale of financial intermediaries. Available at SSRN https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2669836.
- Adrian, T., & Brunnermeier, M. K. (2016). CoVaR. *The American Economic Review*, 106(7), 1705.
- Adrian, T., Colla, P., & Shin, S. S. (2012). Which Financial Frictions? Parsing the Evidence from the Financial Crisis of 2007-09. NBER Working Paper N. 18335, National Bureau of Economic Research, Cambridge, MA.
- Adrian, T., Etula, E., & Muir, T. (2014). Financial intermediaries and the cross-section of asset returns. *The Journal of Finance*, 69(6), 2557–2596.
- Adrian, T., Moench, E., & Shin, H. S. (2010). Financial intermediation, asset prices, and macroeconomic dynamics. Federal Reserve Bank of New York, Staff Reports N. 442.
- Adrian, T., Moench, E., & Shin, H. S. (2016). Dynamic leverage asset pricing. Available at SSRN <https://ssrn.com/abstract=2831970>.
- Adrian, T., & Shin, H. S. (2010). Liquidity and leverage. *Journal of Financial Intermediation*, 19(3), 418–437.
- Aldasoro, I., Avdjiev, S., Borio, C. E., & Disyatat, P. (2020). Global and domestic financial cycles: variations on a theme. BIS Working Paper, N. 864.
- Avcı, E., & Çatak, Ç. (2016). Determinants of bank capital structure and procyclicality of leverage: an empirical analysis from Turkey. *Marmara Business Review*, 1(2), 41–57.
- Aymanns, C., & Farmer, J. D. (2015). The dynamics of the leverage cycle. *Journal of Economic Dynamics and Control*, 50, 155–179.
- Baglioni, A., Beccalli, E., Boitani, A., & Monticini, A. (2013). Is the leverage of European banks procyclical? *Empirical Economics*, 45(3), 1251–1266.
- Baltzer, M., Koehl, A., & Reitz, S. (2020). Procyclical leverage in Europe and its role in asset pricing. *Journal of International Money and Finance*, 107, 102220.
- Bank for International Settlements. (2008). *Addressing Financial System Procyclicality: A Possible Framework*. Note for the FSF Working Group on Market and Institutional Resilience.
- Beccalli, E., Boitani, A., & Di Giuliantonio, S. (2015). Leverage pro-cyclicality and securitization in US banking. *Journal of Financial Intermediation*, 24(2), 200–230.
- Bellavite Pellegrini, C., Cincinelli, P., Meoli, M., & Urga, G. (2022a). The role of shadow banking in systemic risk in the European financial system. *Journal of Banking & Finance*, 138, 106422.
- Bellavite Pellegrini, C., Cincinelli, P., Meoli, M., & Urga, G. (2022b). The contribution of (shadow) banks and real estate to systemic risk in China. *Journal of Financial Stability*, 60, 101018.
- Benoit, S., Colliard, J.-E., Hurlin, C., & Pérignon, C. (2017). Where the risks lie: A survey on systemic risk. *Review of Finance*, 21(1), 109–152.

- Bernanke, B., & Gertler, M. (1989). Agency costs, net worth, and business fluctuations. *The American Economic Review*, 79(1), 14–31.
- Bevilacqua, M., Tunaru, R., & Viotto, D. (2023). Options-based systemic risk, financial distress, and macroeconomic downturns. *Journal of Financial Markets*, 65, 100834.
- BIS, Bank for International Settlements. (2009). Consultative document. International framework for liquidity risk measurement, standards and monitoring.
- BIS, Bank for International Settlements. (2022). Statistical release: BIS international banking statistics and global liquidity indicators at end-December 2021.
- Borio, C., Furfine, C., & Lowe, P. (2001). Procyclicality of the financial system and financial stability: issues and policy options. Bank for International Settlements Papers, N.1. *Marrying the Macro and Microprudential Dimensions of Financial Stability*.
- Bostandzic, D., & Weiss, G. N. (2018). Why do some banks contribute more to global systemic risk? *Journal of Financial Intermediation*, 35, 17–40.
- Brownlees, C., & Engle, R. F. (2016). SRISK: A conditional capital shortfall measure of systemic risk. *The Review of Financial Studies*, 30(1), 48–79.
- Caporin, M., Costola, M., Garibal, J.-C., & Maillet, B. (2022). Systemic risk and severe economic downturns: A targeted and sparse analysis. *Journal of Banking & Finance*, 134, 106339.
- Christiansen, C., Rinaldo, A., & Söderlind, P. (2011). The time-varying systematic risk of carry trade strategies. *Journal of Financial and Quantitative Analysis*, 46(4), 1107–1125.
- Cincinelli, P., Pellini, E., & Urga, G. (2021). Leverage and systemic risk pro-cyclicality in the Chinese financial system. *International Review of Financial Analysis*, 78, 101895.
- Coricelli, F., Driffield, N., Pal, S., & Roland, I. (2012). When does leverage hurt productivity growth? a firm-level analysis. *Journal of International Money and Finance*, 31(6), 1674–1694.
- Damar, H. E., Meh, C. A., & Terajima, Y. (2013). Leverage, balance-sheet size and wholesale funding. *Journal of Financial Intermediation*, 22(4), 639–662.
- Danielsson, J., James, K. R., Valenzuela, M., & Zer, I. (2016). Model risk of risk models. *Journal of Financial Stability*, 23, 79–91.
- Dewasurendra, S., Judice, P., & Zhu, Q. (2019). The optimum leverage level of the banking sector. *Risks*, 7(2), 51.
- Dićpinigaitienė, V., & Novickytė, L. (2018). Application of systemic risk measurement methods: A systematic review and meta-analysis using a network approach. *Quantitative Finance and Economics*, 2, 798–820.
- Dumitrescu, E.-I., & Hurlin, C. (2012). Testing for Granger non-causality in heterogeneous panels. *Economic Modelling*, 29(4), 1450–1460.
- Elliott, D., Meisenzahl, R. R., & Peydró, J.-L. (2023). Nonbank Lenders as Shock Absorbers: Evidence from US Monetary Policy Spillovers. Staff Working Paper N. 1102, Bank of England, London.
- European Central Bank. (2021). *Non-bank Financial Intermediation in the Euro Area: Implications for Monetary Policy Transmission and Key Vulnerabilities*. Occasional Paper Series N. 270/September 2021. Revised December 2021. December 2021.
- Financial Stability Board. (2009). *Report of the Financial Stability Forum on Addressing Procyclicality in the Financial System*. April 2009.
- Financial Stability Board. (2021a). *Enhancing the Resilience of Non-Bank Financial Intermediation*. November 2021.
- Financial Stability Board. (2021b). *Global Monitoring Report on Non-Bank Financial Intermediation*. December 2021.
- Fostel, A., & Geanakoplos, J. (2008). Leverage cycles and the anxious economy. *American Economic Review*, 98(4), 1211–44.

- Giglio, S., Kelly, B., & Pruitt, S. (2016). Systemic risk and the macroeconomy: An empirical evaluation. *Journal of Financial Economics*, 119(3), 457–471.
- Granger, C. W. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica*, 37(3), 424–438.
- Gropp, R., & Heider, F. (2010). The determinants of bank capital structure. *Review of Finance*, 14(4), 587–622.
- Grundke, P., & Tuchscherer, M. (2019). Global systemic risk measures and their forecasting power for systemic events. *The European Journal of Finance*, 25(3), 205–233.
- Hansen, B. E. (1999). Threshold effects in non-dynamic panels: Estimation, testing, and inference. *Journal of Econometrics*, 93(2), 345–368.
- Hansen, B. E. (2000). Sample splitting and threshold estimation. *Econometrica*, 68(3), 575–603.
- Horváth, B. L., & Wagner, W. (2017). The disturbing interaction between countercyclical capital requirements and systemic risk. *Review of Finance*, 21(4), 1485–1511.
- International Monetary Fund. (2021). *Global Financial Stability Report*. October 2021.
- Kalemli-Ozcan, S., Sorensen, B., & Yesiltas, S. (2012). Leverage across firms, banks, and countries. *Journal of International Economics*, 88(2), 284–298.
- Kiyotaki, N., & Moore, J. (1997). Credit cycles. *Journal of Political Economy*, 105(2), 211–248.
- Koenker, R., & Bassett, G. (1978). Regression quantiles. *Econometrica*, 46(1), 33–50.
- López-Espinosa, G., Moreno, A., Rubia, A., & Valderrama, L. (2012). Short-term wholesale funding and systemic risk: A global CoVaR approach. *Journal of Banking & Finance*, 36(12), 3150–3162.
- Mian, A., & Sufi, A. (2011). House prices, home equity-based borrowing, and the US household leverage crisis. *American Economic Review*, 101(5), 2132–56.
- Miranda-Agrippino, S., & Rey, H. (2020). US monetary policy and the global financial cycle. *The Review of Economic Studies*, 87(6), 2754–2776.
- Pesaran, M. H. (2007). A simple panel unit root test in the presence of cross-section dependence. *Journal of Applied Econometrics*, 22(2), 265–312.
- Sedunov, J. (2016). What is the systemic risk exposure of financial institutions? *Journal of Financial Stability*, 24, 71–87.
- Shleifer, A., & Vishny, R. W. (2010). Unstable banking. *Journal of Financial Economics*, 97(3), 306–318.
- van Dijk, D., Teräsvirta, T., & Franses, P. H. (2002). Smooth transition autoregressive models—A survey of recent developments. *Econometric Reviews*, 21(1), 1–47.
- Varotto, S., & Zhao, L. (2018). Systemic risk and bank size. *Journal of International Money and Finance*, 82, 45–70.
- Zhang, Q., Vallascas, F., Keasey, K., & Cai, C. X. (2015). Are market-based measures of global systemic importance of financial institutions useful to regulators and supervisors? *Journal of Money, Credit and Banking*, 47(7), 1403–1442.

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Figure 1: Quasi-market and accounting leverage - European financial institutions.

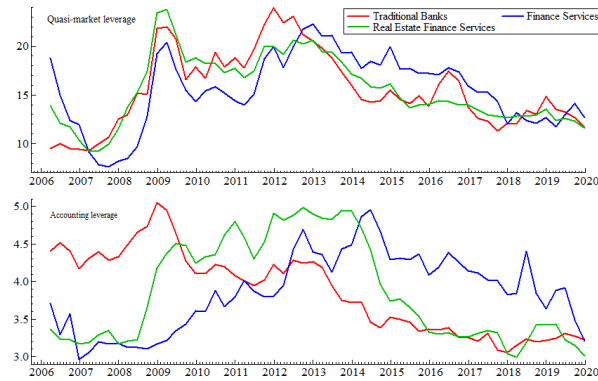
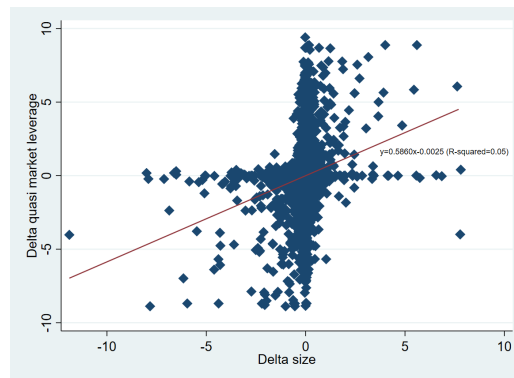
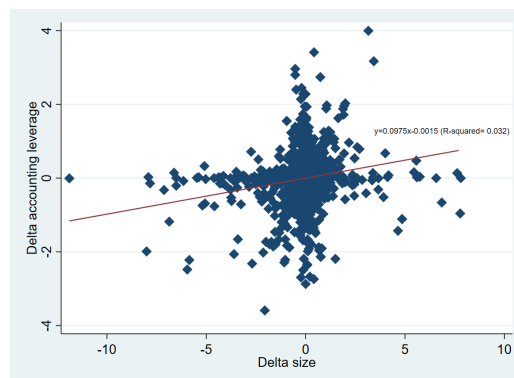


Figure 2: Relationship between leverage and total asset growth - European Financial System.

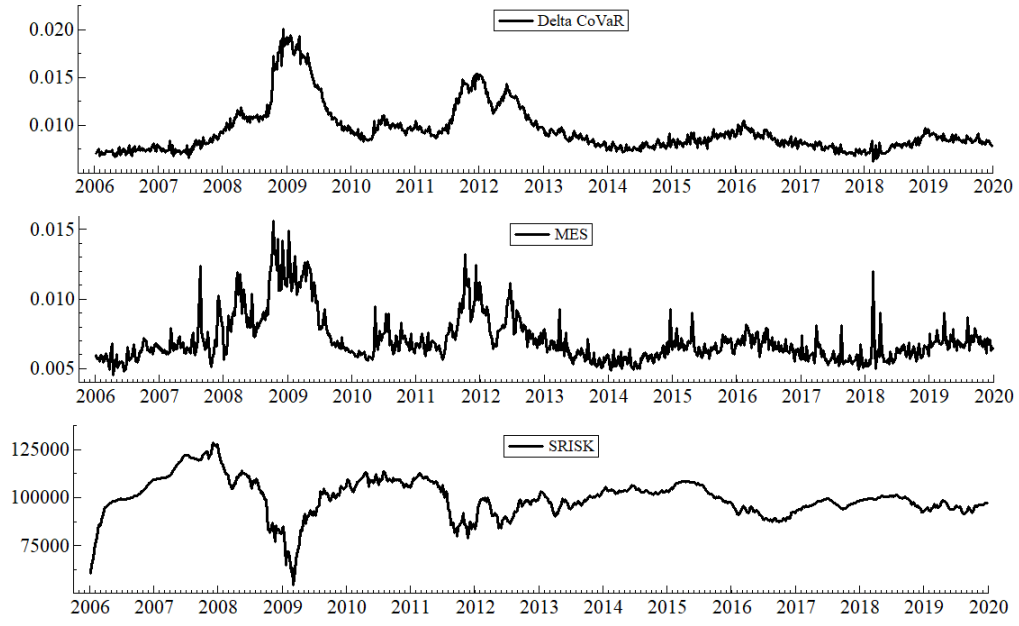


(a) Quasi-market leverage



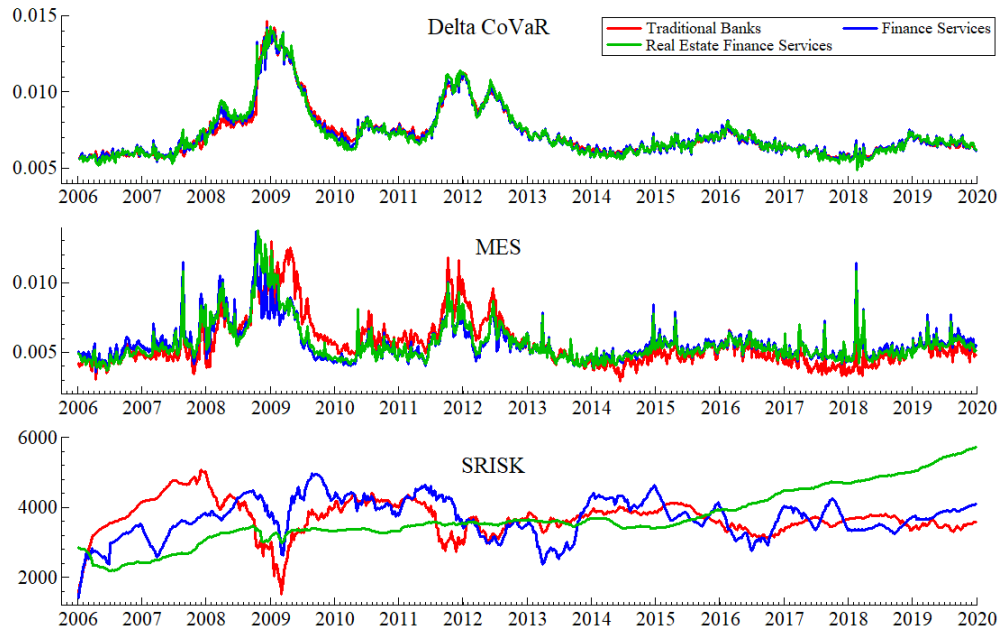
(b) Accounting leverage

Figure 3: Systemic Risk Measures - European Financial System.



$\Delta CoVaR$, MES , $SRISK$ trend for the European Financial System, from 1st January 2006 to 31st December 2019.

Figure 4: $\Delta CoVaR$, MES , $SRISK$ - TBs, FSs, REFs.



$\Delta CoVaR$, MES , $SRISK$ trend for European Traditional Banks, Finance Services, and Real Estate Finance Developers, from 1st January 2006 to 31st December 2019.

Figure 5: Relationship between Systemic Risk Measures and Assets Growth - European Financial System.

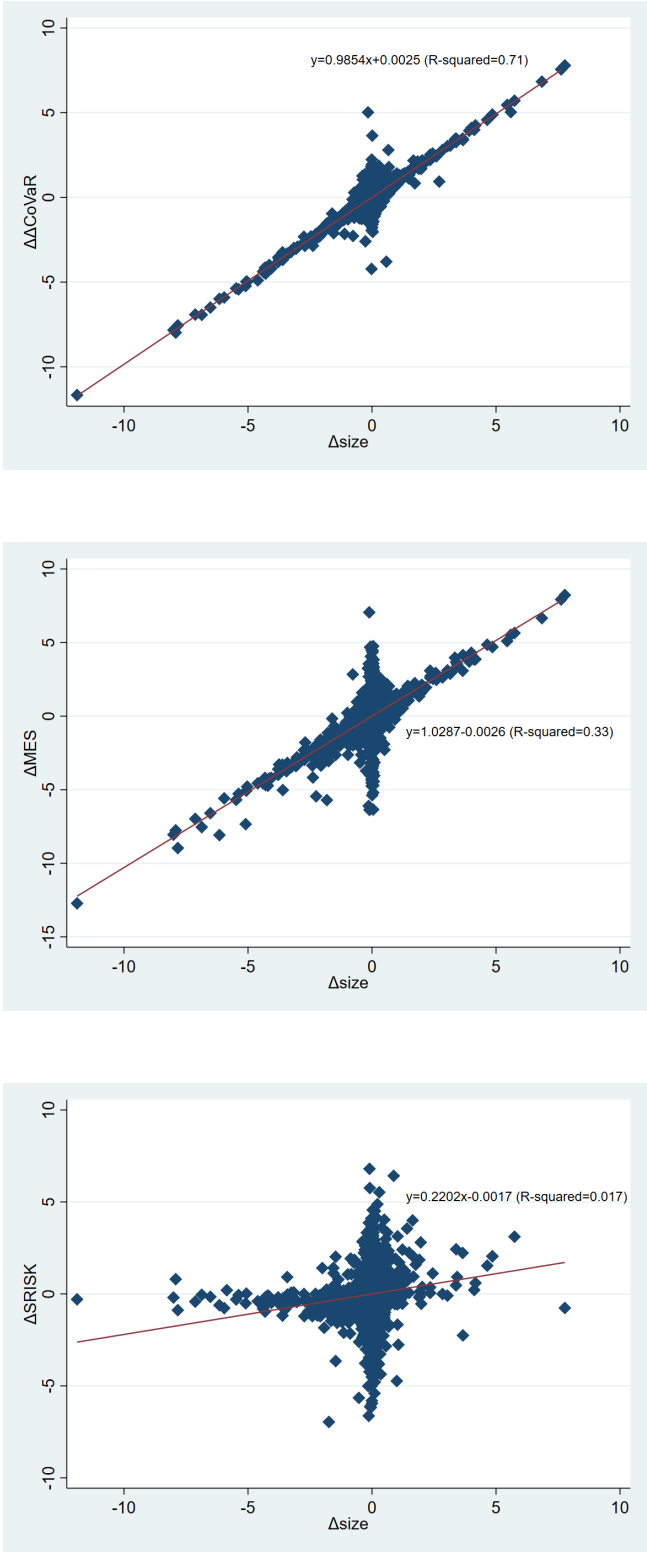
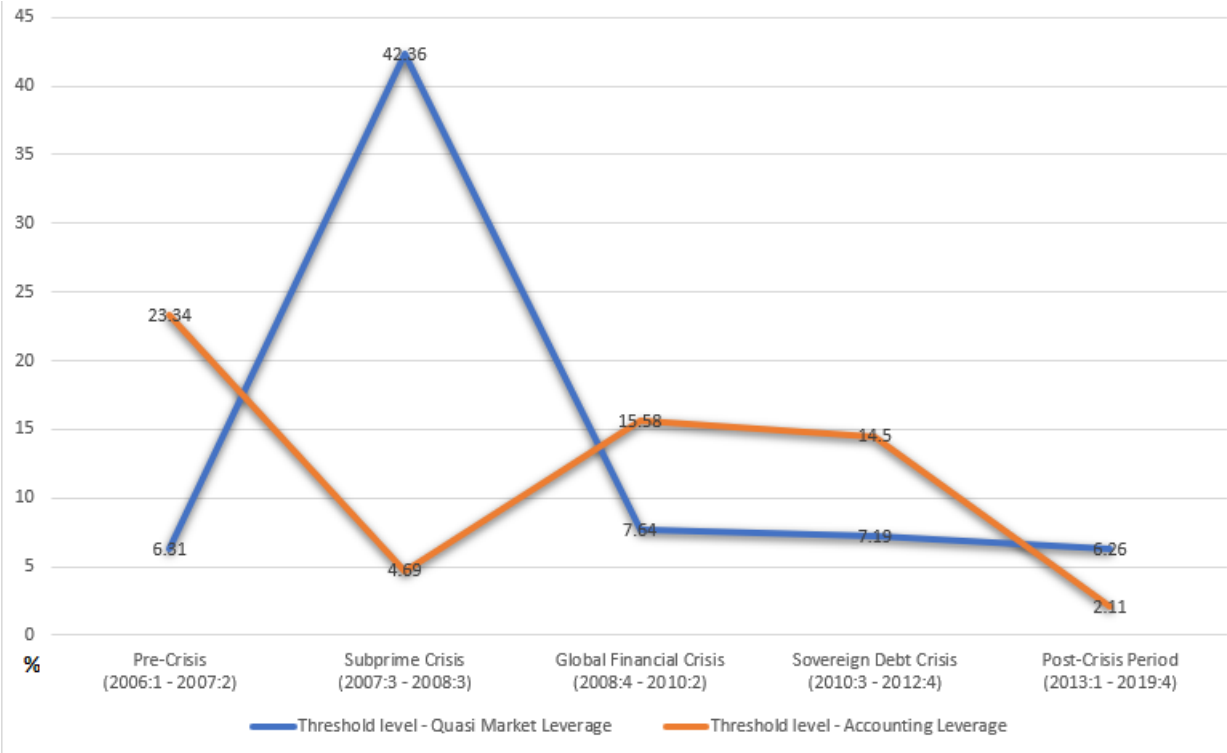


Figure 6: Threshold levels for Quasi-Market and Accounting Leverage.



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Table 1: Financial institutions characteristics - Summary statistics.

	Variable	Mean	Std. Dev.	Min.	Max.
European Financial System	Total assets Thousands of €	44,680,025.54	216,250,659.56	221.00	2,020,000,000.00
	Size (ln)	12.70	3.24	0.00	21.67
	Size growth (%)	0.45	12.53	-65.83	59.60
	Quasi-market leverage (%)	17.84	27.40	0.01	131.29
	Quasi-market leverage growth (%)	0.01	30.37	-104.18	93.00
	Accounting leverage (%)	6.25	8.48	1.00	54.76
	Accounting leverage growth (%)	-0.08	9.76	-48.89	44.64
Traditional Banks	Total assets Thousands of €	181,952,980.29	415,357,651.66	9,792.00	2,020,000,000.00
	Size (ln)	16.49	2.64	7.18	21.67
	Size growth (%)	1.09	5.60	-21.28	23.54
	Quasi-market leverage (%)	42.10	40.84	0.01	131.29
	Quasi-market leverage growth (%)	0.64	27.75	-73.97	77.71
	Accounting leverage (%)	14.27	8.62	1.13	52.28
	Accounting leverage growth (%)	-0.25	7.45	-33.88	27.86
Non Bank Financial Intermediaries	Total assets Thousands of €	2,075,645.78	8,701,144.33	221.00	79,640,400.00
	Size (ln)	11.65	2.53	0.00	20.76
	Size growth (%)	0.28	13.84	-65.83	59.60
	Quasi-market leverage (%)	11.15	17.05	0.01	71.85
	Quasi-market leverage growth (%)	-0.17	31.06	-104.18	93.00
	Accounting leverage (%)	4.04	6.97	1.00	54.76
	Accounting leverage growth (%)	-0.03	10.31	-48.89	44.64
Finance Services	Total assets Thousands of €	2,824,489.54	10,950,136.27	221.00	79,640,400.00
	Size (ln)	11.42	2.71	0.00	20.76
	Size growth (%)	0.14	14.38	-65.83	59.60
	Quasi-market leverage (%)	8.37	15.20	0.01	59.62
	Quasi-market leverage growth (%)	-0.44	33.57	-104.18	93.00
	Accounting leverage (%)	4.15	7.54	1.00	54.76
	Accounting leverage growth (%)	0.01	10.64	-48.89	44.64
Real Estate Finance Services	Total assets Thousands of €	880,753.05	1,694,669.30	284.00	10,560,930.00
	Size (ln)	12.01	2.18	1.95	17.14
	Size growth (%)	0.50	12.93	-62.31	56.21
	Quasi-market leverage (%)	15.56	18.80	0.01	71.85
	Quasi-market leverage growth (%)	0.26	26.58	-74.97	73.35
	Accounting leverage (%)	3.87	5.96	1.01	46.57
	Accounting leverage growth (%)	-0.09	9.76	-44.55	43.75

The table reports quarterly summary statistics of listed European financial institutions: Traditional Banks, Non Bank Financial Intermediaries, Finance Services, Real Estate Finance Services over the time period 2006:1 to 2019:4. $Size_{i,t}$ is natural logarithm of the total assets of financial institution i at quarter t ; $\Delta Size_{i,t}$ is the quarterly growth of total assets of financial institution i ; *Quasi – market leverage* $_{i,t}$ is the quasi-market leverage ratio defined as the market value of assets (market capitalization of equity plus debt) over market capitalization (equal to the share price multiplied by the number of shares outstanding) of financial institution i at quarter t ; *AccountingLeverage* $_{i,t}$ is the total assets to equity ratio of financial institution i at quarter t .

Table 2: Financial institutions characteristics for the different sub-periods summary statistics.

Variable	Pre-Crisis - 2006:1 - 2007:2									
	European Financial System					Traditional Banks				
	Mean	Std. Dev.	Min.	Max.		Mean	Std. Dev.	Min.	Max.	
Total assets Thousands of €	37,031,516.82	179,779,740.52	221.00	1,940,000,000.00		151,260,321.21	340,553,970.91	9,792.00	1,940,000,000.00	
Size (h)	12.64	3.10	3.74	21.38		16.27	2.66	7.98	21.38	
Size growth (%)	1.51	20.20	-65.83	59.60		2.73	8.63	-21.28	59.60	
Quasi-market leverage (%)	13.42	21.75	0.01	131.29		29.79	31.53	0.01	131.29	
Quasi-market leverage growth (%)	-3.68	35.67	-104.18	93.00		1.70	29.76	-73.97	77.71	
Accounting leverage (%)	6.13	8.31	1.00	54.76		15.39	9.36	1.13	52.28	
Accounting leverage growth (%)	0.02	11.98	-48.89	44.64		-0.04	9.30	-33.88	27.86	
Sub-Prime Crisis - 2007:3 - 2008:3										
Variable	European Financial System					Traditional Banks				
	Mean	Std. Dev.	Min.	Max.		Mean	Std. Dev.	Min.	Max.	
Total assets Thousands of €	42,791,374.55	214,772,998.36	221.00	2,020,000,000.00		175,848,981.63	415,250,931.30	9,792.00	2,020,000,000.00	
Size (h)	12.64	3.13	4.74	21.67		16.34	2.68	8.05	21.67	
Size growth (%)	0.84	14.42	-65.83	59.60		2.65	6.61	-21.28	23.54	
Quasi-market leverage (%)	14.81	24.61	0.01	131.29		36.50	38.22	0.01	131.29	
Quasi-market leverage growth (%)	7.48	32.21	-104.18	93.00		7.65	27.72	-73.97	77.71	
Accounting leverage (%)	6.12	8.24	1.00	54.76		15.55	9.86	1.13	52.28	
Accounting leverage growth (%)	0.72	10.35	-48.89	44.64		1.02	6.98	-33.88	27.86	
Global Financial Crisis - 2008:4 - 2010:2										
Variable	European Financial System					Traditional Banks				
	Mean	Std. Dev.	Min.	Max.		Mean	Std. Dev.	Min.	Max.	
Total assets Thousands of €	45,305,308.87	227,779,432.48	221.00	2,020,000,000.00		189,413,418.90	441,493,474.91	9,792.00	2,020,000,000.00	
Size (h)	12.59	3.21	2.83	21.64		16.39	2.70	7.60	21.64	
Size growth (%)	-0.52	12.67	-65.83	59.60		0.98	6.01	-21.28	23.54	
Quasi-market leverage (%)	20.72	29.61	0.01	131.29		48.75	42.40	0.01	131.29	
Quasi-market leverage growth (%)	2.26	34.54	-104.18	93.00		4.13	33.16	-73.97	77.71	
Accounting leverage (%)	6.55	8.81	1.00	54.76		15.71	9.81	1.13	52.28	
Accounting leverage growth (%)	0.36	10.22	-48.89	44.64		-0.56	8.55	-33.88	27.86	
Sovereign Debt Crisis - 2010:3 - 2012:4										
Variable	European Financial System					Commercial Banks				
	Mean	Std. Dev.	Min.	Max.		Mean	Std. Dev.	Min.	Max.	
Total assets Thousands of €	47,655,991.59	252,803,083.39	221.00	2,020,000,000.00		196,050,317.89	448,980,376.72	9,792.00	2,020,000,000.00	
Size (h)	12.63	3.26	2.94	21.55		16.46	2.70	7.72	21.55	
Size growth (%)	0.07	10.70	-65.83	59.60		0.53	5.23	-21.28	23.54	
Quasi-market leverage (%)	21.51	31.33	0.01	131.29		52.86	45.84	0.01	131.29	
Quasi-market leverage growth (%)	0.49	29.16	-104.18	93.00		0.28	25.32	-73.97	77.71	
Accounting leverage (%)	6.70	9.19	1.00	54.76		14.87	9.15	1.13	52.28	
Accounting leverage growth (%)	0.03	9.71	-48.89	44.64		-0.37	7.77	-33.88	27.86	
Post-Crisis - 2013:1 - 2019:4										
Variable	European Financial System					Traditional Banks				
	Mean	Std. Dev.	Min.	Max.		Mean	Std. Dev.	Min.	Max.	
Total assets Thousands of €	45,243,494.72	214,952,966.34	221.00	2,020,000,000.00		183,258,350.21	411,859,522.41	9,792.00	2,020,000,000.00	
Size (h)	12.77	3.28	0.00	21.64		16.60	2.59	7.18	21.64	
Size growth (%)	0.62	10.86	-65.83	59.60		0.80	4.58	-21.28	23.54	
Quasi-market leverage (%)	17.08	26.44	0.01	131.29		39.80	39.44	0.01	131.29	
Quasi-market leverage growth (%)	-1.22	27.91	-104.18	93.00		-1.42	26.21	-73.97	77.71	
Accounting leverage (%)	6.05	8.17	1.00	54.76		13.21	7.49	1.13	52.28	
Accounting leverage growth (%)	-0.37	9.69	-48.89	44.64		-0.35	6.62	-33.88	27.86	

The table reports quarterly summary statistics of listed European financial institutions: Traditional Banks, Finance Services, Real Estate Finance Services over the time period 2006:1 to 2019:4. $Size_{i,t}$ is the natural logarithm of the total assets of financial institution i at quarter t ; $\Delta Size_{i,t}$ is the quarterly growth of total assets of financial institution i ; $Quasi - Market Leverage_{i,t}$ is the quasi-market leverage ratio defined as the market value of assets (market capitalization of equity plus debt) over market capitalization (equal to the share price multiplied by the number of shares outstanding) of financial institution i at quarter t ; $Accounting Leverage_{i,t}$ is the total assets to equity ratio of financial institution i at quarter t .

Table 3: $\Delta CoVaR$, MES , $SRISK$ summary statistics.

	Variable	Mean	Std. Dev.	Min.	Max.
Entire Financial System	$\Delta CoVaR$ (%)	1.04	1.27	-9.49	17.5
	MES (%)	0.78	1.15	-7.91	38.14
	$SRISK$ (€)	120,460.43	524,348.74	-10,857.50	8,421,818.00
Traditional Banks	$\Delta CoVaR$ (%)	1.76	1.71	-2.61	17.5
	MES (%)	1.3	1.54	-3.39	21.39
	$SRISK$ (€)	461,094.02	963,001.61	-7,003.52	8,421,818.00
Finance Services	$\Delta CoVaR$ (%)	0.8	1.01	-9.49	11.35
	MES (%)	0.59	0.86	-7.91	25.84
	$SRISK$ (€)	5,365.96	30,094.42	-10,857.50	538,323.69
Real Estate Finance Services	$\Delta CoVaR$ (%)	0.84	0.97	-4.68	9.78
	MES (%)	0.64	1.05	-3.92	38.14
	$SRISK$ (€)	3,895.21	7,762.65	-3,564.70	89,388.30

The table reports weekly summary statistics of the three measures of systemic risk for the sample of listed European financial institutions. $\Delta CoVaR$, MES , $SRISK$ are computed over the period 1st January 2006 to 31st December 2019, expressed in percentages in relation to the: (i) Entire Financial System; (ii) Traditional Banks; (iii) Finance Services; (iv) Real Estate Finance Services.

Table 4: Threshold Quasi-Market Leverage pro-cyclicality.

Dependent variable: Δ Quasi-Market Leverage		Full period (2006:1-2019:4)	Pre-Crisis (2006:1-2007:2)	Subprime Crisis (2007:3-2008:3)	Global Financial Crisis (2008:4-2010:2)	Sovereign Debt Crisis (2010:3-2012:4)	Post-Crisis Period (2013:1-2019:4)
		[i]	[ii]	[iii]	[iv]	[v]	[vi]
Entire Financial System	γ =Quasi-Market Leverage $_{t-1}$ (%)	5.31**	6.31***	42.36**	7.64***	7.19	6.26***
	$\Delta Size_{it} (Leverage_{it,t-1} \leq \gamma)$	0.4261*** (0.0790)	0.8386*** (0.1458)	0.6808*** (0.1115)	0.1296 (0.1338)	0.2833** (0.1174)	0.3015*** (0.0877)
	$\Delta Size_{it} (Leverage_{it,t-1} > \gamma)$	0.5533*** (0.0393)	0.3540** (0.1177)	-0.2725 (0.2358)	0.5866*** (0.1352)	0.4596*** (0.1222)	0.6374*** (0.0523)
	Constant	-0.0698*** (0.0127)	-0.0710*** (0.0027)	0.0677 (0.0009)	0.0229*** (0.0006)	0.0055*** (0.0006)	-0.0189 (0.0002)
	N. Obs.	27,216	2,016	2,016	4,032	5,040	14,112
	Fixed Effects	YES	YES	YES	YES	YES	YES
	Time dummies	YES	NO	NO	NO	NO	NO
	R^2	0.05	0.07	0.07	0.02	0.01	0.04
Traditional Banks	γ =Quasi-Market Leverage $_{t-1}$ (%)	55.26	49.92	87.00	28.62	88.81	28.03**
	$\Delta Size_{it} (Leverage_{it,t-1} \leq \gamma)$	0.6091*** (0.1287)	0.3666 (0.3717)	0.4992*** (0.2008)	0.058 (0.4016)	0.4928 (0.2994)	1.2500*** (0.2084)
	$\Delta Size_{it} (Leverage_{it,t-1} > \gamma)$	0.3647*** (0.1237)	-0.3518 (0.5690)	3.0453*** (0.9809)	0.5931*** (0.2672)	-0.7771 (1.2291)	0.5192*** (0.2202)
	Constant	-0.0139 (0.0201)	-0.0032 (0.0117)	0.0652 (0.0049)	0.0351 (0.0022)	-0.0016 (0.0014)	-0.0276 (0.0011)
	N. Obs.	6,156	456	456	912	1,140	3,192
	Fixed Effects	YES	YES	YES	YES	YES	YES
	Time dummies	YES	NO	NO	NO	NO	NO
	R^2	0.05	0.01	0.03	0.01	0.01	0.03
Finance Services	γ =Quasi-Market Leverage $_{t-1}$ (%)	7.36***	6.08	37.33	7.72***	4.18	7.32***
	$\Delta Size_{it} (Leverage_{it,t-1} \leq \gamma)$	0.4083*** (0.0740)	0.9144*** (0.2152)	0.5969*** (0.1496)	0.1295 (0.1705)	0.2401 (0.1603)	0.3075*** (0.0833)
	$\Delta Size_{it} (Leverage_{it,t-1} > \gamma)$	0.6594*** (0.0831)	0.3278 (0.2064)	-0.3069 (0.3373)	0.8164*** (0.1852)	0.5562*** (0.0005)	0.6858*** (0.0928)
	Constant	-0.0595 (0.0232)	-0.0854 (0.0043)	0.0521 (0.0021)	0.0051*** (0.0015)	0.0073*** (0.1798)	-0.0129 (0.0006)
	N. Obs.	11,286	836	836	1,672	2,090	5,852
	Fixed Effects	YES	YES	YES	YES	YES	YES
	Time dummies	YES	NO	NO	NO	NO	NO
	R^2	0.05	0.08	0.06	0.04	0.02	0.03
Real Estate Finance Services	γ =Quasi-Market Leverage $_{t-1}$ (%)	48.49**	7.48**	7.96**	33.42	18.01	56.87**
	$\Delta Size_{it} (Leverage_{it,t-1} \leq \gamma)$	0.5579*** (0.0526)	0.7636*** (0.1716)	0.9239*** (0.1947)	0.2117 (0.1499)	0.1695 (0.1391)	0.6298*** (0.0695)
	$\Delta Size_{it} (Leverage_{it,t-1} > \gamma)$	0.1951 (0.1549)	0.3372** (0.1589)	0.2375 (0.3037)	-0.0561 (0.3062)	0.5406*** (0.1746)	0.0528 (0.2790)
	Constant	-0.1181*** (0.0190)	-0.0964*** (0.0047)	0.0814*** (0.0047)	0.0357 (0.0014)	0.0081*** (0.0004)	-0.0227 (0.0005)
	N. Obs.	9,774	724	724	1,448	1,840	5,068
	Fixed Effects	YES	YES	YES	YES	YES	YES
	Time dummies	YES	NO	NO	NO	NO	NO
	R^2	0.08	0.1	0.14	0.004	0.01	0.06

The table reports regressions using alternative specifications. The dependent variables is Δ Quasi-Market Leverage. γ is the threshold level measured by Quasi-market Leverage $_{t-1}$. $\Delta Size_{it}$ is the increase in size (as natural logarithm of total assets) for financial institution i at quarter t . Specification [i] refers to over full period (2006:1-2019:4); Specification [ii] refers to Pre-Crisis Period (2006:1-2007:2); Specification [iii] refers to Sub-Prime Crisis (2007:3-2008:3); Specification [iv] refers to Global Financial Crisis (2008:4 - 2010:2); Specification [v] refers to Sovereign Debt Crisis (2010:3-2012:4); Specification [vi] refers to Post-Crisis Period (2013:1-2019:4). Robust standard errors are reported in parentheses.
*, **, *** denote the 10%, 5% and 1% significance level, respectively.

Table 5: Threshold Accounting Leverage pro-cyclicality.

Dependent variable: $\Delta \text{Accounting Leverage}$		Full period (2006:1-2019:4)	Pre-Crisis (2006:1-2007:2)	Subprime Crisis (2007:3-2008:3)	Global Financial Crisis (2008:4-2010:2)	Sovereign Debt Crisis (2010:3-2012:4)	Post-Crisis Period (2013:1-2019:4)
		[i]	[ii]	[iii]	[iv]	[v]	[vi]
Entire Financial System	$\gamma = \text{Accounting Leverage}_{t-1} (\%)$	13.61***	23.34**	4.69***	15.58***	14.50***	2.11***
	$\Delta \text{Size}_{e,t} (\text{Leverage}_{t,t-1} \leq \gamma)$	0.1913***	0.2344***	0.1911***	0.1785***	0.1705**	0.1736***
		(0.0205)	(0.0550)	(0.0498)	(0.0414)	(0.0554)	(0.0302)
	$\Delta \text{Size}_{e,t} (\text{Leverage}_{t,t-1} > \gamma)$	0.3845***	0.5966***	0.4527***	0.6567***	0.5797***	0.3071***
		(0.0629)	(0.0993)	(0.1263)	(0.0868)	(0.1020)	(0.0455)
	Constant	-0.0125**	-0.0066***	0.0047***	0.0043***	0.0005***	-0.0051
		(0.0037)	(0.0013)	(0.0004)	(0.0002)	(0.0001)	(0.0001)
	N. Obs.	32,238	2,388	2,388	4,776	5,970	16,716
	Fixed Effects	YES	YES	YES	YES	YES	YES
	Time dummies	YES	NO	NO	NO	NO	NO
	R^2	0.07	0.1	0.13	0.09	0.07	0.08
Traditional Banks	$\gamma = \text{Accounting Leverage}_{t-1} (\%)$	5.31***	4.84*	18.63	42.42	3.78***	5.21***
	$\Delta \text{Size}_{e,t} (\text{Leverage}_{t,t-1} \leq \gamma)$	0.1308	0.8931*	0.4056***	0.5876***	-0.2602	0.0103
		(0.2472)	(0.4193)	(0.1108)	(0.0874)	(0.3696)	(0.0417)
	$\Delta \text{Size}_{e,t} (\text{Leverage}_{t,t-1} > \gamma)$	0.4703***	0.2429*	0.0563	0.1939	0.5359***	0.5831***
		(0.0500)	(0.1386)	(0.1722)	(0.6364)	(0.0883)	(0.0654)
	Constant	-0.0324	-0.130	0.0016	-0.0113	-0.0064	-0.0079
		(0.0052)	(0.0048)	(0.0025)	(0.0008)	(0.0004)	(0.0005)
	N. Obs.	6,966	516	516	1,032	1,290	3,612
	Fixed Effects	YES	YES	YES	YES	YES	YES
	Time dummies	YES	NO	NO	NO	NO	NO
	R^2	0.12	0.11	0.09	0.1383	0.11	0.14
Finance Services	$\gamma = \text{Accounting Leverage}_{t-1} (\%)$	1.91***	28.73**	4.73***	15.18**	14.4***	2.10***
	$\Delta \text{Size}_{e,t} (\text{Leverage}_{t,t-1} \leq \gamma)$	0.145***	0.1760**	0.1347**	0.2025***	0.2034**	0.1741***
		(0.0265)	(0.0789)	(0.0562)	(0.0503)	(0.0756)	(0.0348)
	$\Delta \text{Size}_{e,t} (\text{Leverage}_{t,t-1} > \gamma)$	0.2972***	0.6171***	0.5361**	0.7271***	0.6276***	0.3600***
		(0.0474)	(0.0919)	(0.1669)	(0.1184)	(0.1073)	(0.0630)
	Constant	-0.0110	-0.0041	0.00736***	0.0026***	0.0016***	-0.0017
		(0.0051)	(0.0014)	(0.0008)	(0.0004)	(0.0001)	(0.0001)
	N. Obs.	15,498	1,148	1,148	2,296	2,870	8,036
	Fixed Effects	YES	YES	YES	YES	YES	YES
	Time dummies	YES	NO	NO	NO	NO	NO
	R^2	0.09	0.09	0.15	0.13	0.11	0.11
Real Estate Finance Services	$\gamma = \text{Accounting Leverage}_{t-1} (\%)$	1.03**	3.06**	1.26	1.03***	3.41**	2.69*
	$\Delta \text{Size}_{e,t} (\text{Leverage}_{t,t-1} \leq \gamma)$	0.4050***	0.2423**	0.4612***	0.6956***	-0.0154	0.2132***
		(0.0794)	(0.0828)	(0.1123)	(0.1146)	(0.2265)	(0.0562)
	$\Delta \text{Size}_{e,t} (\text{Leverage}_{t,t-1} > \gamma)$	0.1518***	0.5130***	0.2454**	0.0046	0.2265**	0.1179
		(0.0300)	(0.1113)	(0.1077)	(0.0653)	(0.1039)	(0.0726)
	Constant	-0.0034	-0.0060	0.002	0.0136	0.0016	-0.0098
		(0.0081)	(0.0022)	(0.0024)	(0.0006)	(0.0003)	(0.0003)
	N. Obs.	9,774	724	724	1,448	1,810	5,068
	Fixed Effects	YES	YES	YES	YES	YES	YES
	Time dummies	YES	NO	NO	NO	NO	NO
	R^2	0.05	0.17	0.1516	0.04	0.02	0.04

The table reports regressions using alternative specifications. The dependent variables is $\Delta \text{Accounting Leverage}$. γ is the threshold level measured by Accounting Leverage_{t-1}. $\Delta \text{Size}_{e,t}$ is the increase in size (as natural logarithm of total assets) for financial institution i at quarter t . Specification [i] refers to over full period (2006:1-2019:4); Specification [ii] refers to Pre-Crisis Period (2006:1-2007:2); Specification [iii] refers to Sub-Prime Crisis (2007:3-2008:3); Specification [iv] refers to Global Financial Crisis (2008:4 - 2010:2); Specification [v] refers to Sovereign Debt Crisis (2010:3-2012:4); Specification [vi] refers to Post-Crisis Period (2013:1-2019:4). Robust standard errors are reported in parentheses.
*, **, *** denote the 10%, 5% and 1% significance level, respectively.

Table 6: Threshold Systemic Risk pro-cyclicality - Entire Financial System.

Dependent variable: $\Delta\Delta\text{CoVaR}$	Full period (2006:1-2019:4) [i]	Pre-Crisis (2006:1-2007:2) [ii]	Subprime Crisis (2007:3-2008:3) [iii]	Global Financial Crisis (2008:4-2010:2) [iv]	Sovereign Debt Crisis (2010:3-2012:4) [v]	Post-Crisis Period (2013:1-2019:4) [vi]
$\gamma=\text{Quasi-Market Leverage}_{t-1}$ (%)	63.21***	4.43	16.6	66.17*	58.38***	62.28***
$\Delta\text{Size}_{i,t}(\text{Leverage}_{i,t-1} \leq \gamma)$	0.4770*** (0.0097)	0.4210*** (0.0715)	0.4167*** (0.0206)	0.3460*** (0.0226)	0.4893*** (0.0208)	0.5272*** (0.0147)
$\Delta\text{Size}_{i,t}(\text{Leverage}_{i,t-1} > \gamma)$	0.7654*** (0.0506)	0.4900*** (0.0259)	0.5188*** (0.0543)	0.8175*** (0.1130)	0.9830*** (0.1079)	0.8732*** (0.0948)
Constant	0.0217*** (0.0041)	0.0131*** (0.0006)	0.0543*** (0.0002)	-0.0056*** (0.0001)	0.0106*** (0.0001)	0.0047*** (0.0001)
N. Obs.	27,216	2,016	2,016	4,032	5,040	14,112
Fixed Effects	YES	YES	YES	YES	YES	YES
Time dummies	YES	NO	NO	NO	NO	NO
R^2	0.28	0.38	0.18	0.08	0.14	0.3
$\gamma=\text{Accounting Leverage}_{t-1}$ (%)	1.01***	32.07***	6.31	1.11	13.49	23.50***
$\Delta\text{Size}_{i,t}(\text{Leverage}_{i,t-1} \leq \gamma)$	0.3610*** (0.0428)	0.4866*** (0.0234)	0.4137*** (0.0224)	0.2319*** (0.0539)	0.4834*** (0.0200)	0.5420*** (0.0156)
$\Delta\text{Size}_{i,t}(\text{Leverage}_{i,t-1} > \gamma)$	0.4860*** (0.0099)	0.1484 (0.1465)	0.5207*** (0.0401)	0.3784*** (0.0233)	0.6384*** (0.1289)	0.4378*** (0.0332)
Constant	0.0216*** (0.0041)	0.0129*** (0.0006)	0.0544*** (0.0001)	-0.0052*** (0.0001)	0.0103*** (0.0001)	0.0045*** (0.0001)
N. Obs.	27,216	2,016	2,016	4,032	5,040	14,112
Fixed Effects	YES	YES	YES	YES	YES	YES
Time dummies	YES	NO	NO	NO	NO	NO
R^2	0.28	0.38	0.18	0.08	0.14	0.3
Dependent variable: ΔMES	Full period (2006:1-2019:4) [i]	Pre-Crisis (2006:1-2007:2) [ii]	Subprime Crisis (2007:3-2008:3) [iii]	Global Financial Crisis (2008:4-2010:2) [iv]	Sovereign Debt Crisis (2010:3-2012:4) [v]	Post-Crisis Period (2013:1-2019:4) [vi]
$\gamma=\text{Quasi-Market Leverage}_{t-1}$ (%)	67.23***	10.05	9.05	44.87	60.79***	66.60**
$\Delta\text{Size}_{i,t}(\text{Leverage}_{i,t-1} \leq \gamma)$	0.6766*** (0.0154)	0.6141*** (0.0548)	0.5935*** (0.0476)	0.5453*** (0.0430)	0.5959*** (0.0360)	0.7504*** (0.0248)
$\Delta\text{Size}_{i,t}(\text{Leverage}_{i,t-1} > \gamma)$	1.1117*** (0.0080)	0.7742*** (0.0612)	0.7395*** (0.0648)	0.8349*** (0.1001)	1.4473*** (0.2012)	1.3440*** (0.1453)
Constant	0.0585*** (0.0080)	0.0256*** (0.0011)	0.0422*** (0.0003)	-0.0437*** (0.0002)	-0.0010*** (0.0001)	-0.0135*** (0.0001)
N. Obs.	27,216	2,016	2,016	4,032	5,040	14,112
Fixed Effects	YES	YES	YES	YES	YES	YES
Time dummies	YES	NO	NO	NO	NO	NO
R^2	0.15	0.17	0.11	0.05	0.06	0.13
$\gamma=\text{Accounting Leverage}_{t-1}$ (%)	10.88***	32.07**	1.02	10.2	15.01*	6.11**
$\Delta\text{Size}_{i,t}(\text{Leverage}_{i,t-1} \leq \gamma)$	0.6639*** (0.1718)	0.6961*** (0.0356)	1.0375*** (0.0989)	0.5338*** (0.0449)	0.5806*** (0.0376)	0.7249*** (0.0316)
$\Delta\text{Size}_{i,t}(\text{Leverage}_{i,t-1} > \gamma)$	0.7862*** (0.0360)	0.0478 (0.1143)	0.6104*** (0.0410)	0.7878*** (0.0917)	0.8895*** (0.0992)	0.8438*** (0.0235)
Constant	0.0586*** (0.0080)	0.0248*** (0.0009)	0.0427*** (0.0003)	-0.0442*** (0.0003)	-0.0012*** (0.0001)	-0.0135*** (0.0001)
N. Obs.	27,216	2,016	2,016	4,032	5,040	14,112
Fixed Effects	YES	YES	YES	YES	YES	YES
Time dummies	YES	NO	NO	NO	NO	NO
R^2	0.15	0.17	0.11	0.05	0.06	0.13
Dependent variable: ΔSRISK	Full period (2006:1-2019:4) [i]	Pre-Crisis (2006:1-2007:2) [ii]	Subprime Crisis (2007:3-2008:3) [iii]	Global Financial Crisis (2008:4-2010:2) [iv]	Sovereign Debt Crisis (2010:3-2012:4) [v]	Post-Crisis Period (2013:1-2019:4) [vi]
$\gamma=\text{Quasi-Market Leverage}_{t-1}$ (%)	6.31***	4.26***	3.11***	7.64*	8.06*	6.31***
$\Delta\text{Size}_{i,t}(\text{Leverage}_{i,t-1} \leq \gamma)$	0.1958*** (0.0223)	-0.2308** (0.1041)	-0.0892 (0.0880)	0.1782** (0.0574)	0.1851** (0.0641)	0.2148*** (0.0300)
$\Delta\text{Size}_{i,t}(\text{Leverage}_{i,t-1} > \gamma)$	0.3229*** (0.0201)	0.0823** (0.0392)	0.1772*** (0.0447)	0.2981*** (0.0405)	0.3275*** (0.0484)	0.3298*** (0.0296)
Constant	0.0107 (0.0068)	0.0200*** (0.0009)	0.0060*** (0.0005)	0.0052*** (0.0002)	0.0010*** (0.0001)	0.0003*** (0.0001)
N. Obs.	27,216	2,016	2,016	4,032	5,040	14,112
Fixed Effects	YES	YES	YES	YES	YES	YES
Time dummies	YES	NO	NO	NO	NO	NO
R^2	0.04	0.01	0.02	0.03	0.03	0.04
$\gamma=\text{Accounting Leverage}_{t-1}$ (%)	1.29***	7.14*	1.01	2.19***	7.46***	1.10***
$\Delta\text{Size}_{i,t}(\text{Leverage}_{i,t-1} \leq \gamma)$	0.1567*** (0.0294)	-0.0257 (0.0411)	0.9656*** (0.3415)	0.0956 (0.0588)	0.3119*** (0.0407)	0.0858 (0.0550)
$\Delta\text{Size}_{i,t}(\text{Leverage}_{i,t-1} > \gamma)$	0.2749*** (0.0203)	0.2317* (0.1203)	0.0995** (0.0413)	0.3512*** (0.0408)	0.0387 (0.0873)	0.2891*** (0.0243)
Constant	0.0098 (0.0068)	0.0188*** (0.0012)	0.0084*** (0.0005)	0.0052*** (0.0002)	0.0010*** (0.0001)	0.0002** (0.0001)
N. Obs.	27,216	2,016	2,016	4,032	5,040	14,112
Fixed Effects	YES	YES	YES	YES	YES	YES
Time dummies	YES	NO	NO	NO	NO	NO
R^2	0.04	0.006	0.01	0.04	0.03	0.04

The table reports regressions using alternative specifications. The dependent variables are the growth in each systemic risk measure: $\Delta\Delta\text{CoVaR}$, ΔMES , and ΔSRISK . γ is the threshold level measured by Quasi-market Leverage_{t-1} . $\Delta\text{Size}_{i,t}$ is the increase in size (as natural logarithm of total assets) for financial institution i at quarter t . Specification [i] refers to over full period (2006:1-2019:4); Specification [ii] refers to Pre-Crisis Period (2006:1-2007:2); Specification [iii] refers to Sub-Prime Crisis (2007:3-2008:3); Specification [iv] refers to Global Financial Crisis (2008:4 - 2010:2); Specification [v] refers to Sovereign Debt Crisis (2010:3-2012:4); Specification [vi] refers to Post-Crisis Period (2013:1-2019:4). Robust standard errors are reported in parentheses. *, **, *** denote the 10%, 5% and 1% significance level, respectively.

Table 7: Results panel causality test.

	Hypothesis	Wald Statistic	$\bar{Z}$	$\tilde{Z}$	Result	Conclusion
Leverage pro-cyclical	$\Delta \text{Size} \rightarrow \Delta \text{Accounting Leverage}$	1.57	9.05***	7.85***	Yes	Causality from Size to <i>Accounting Leverage</i>
	$\Delta \text{Size} \rightarrow \Delta \text{Quasi-Market Leverage}$	8.17	66.95***	60.69***	Yes	Causality from Size to <i>Quasi-Market Leverage</i>
Systemic risk pro-cyclical	$\Delta \text{Size} \rightarrow \Delta \Delta \text{CoVaR}$	2.99	31.63***	28.91***	Yes	Causality from Size to ΔCoVaR
	$\Delta \text{Size} \rightarrow \Delta \text{MES}$	2.81	28.79***	26.27***	Yes	Causality from Size to <i>MES</i>
	$\Delta \text{Size} \rightarrow \Delta \text{SRISK}$	4.9	61.93***	57.17***	Yes	Causality from Size to <i>SRISK</i>

The table reports the results from Dumitrescu & Hurlin (2012)' test. " $\rightarrow$ " stands for "variable x Granger cause variable y " and viceversa. $WaldStatistic = W_{N,T}^{HNC} = \frac{1}{N} \sum_{i=1}^N W_{i,T}$; $\bar{Z} = \sqrt{\frac{N}{2K}} \times (\bar{W} - K) \xrightarrow[T, N \rightarrow \infty]{d} N(0, 1)$; $\tilde{Z} = \sqrt{\frac{N}{2K}} \times \frac{T-3K-5}{T-2K-3} \times \left(\frac{T-3K-3}{T-3K-1} \times \bar{W} - K \right) \xrightarrow[T, N \rightarrow \infty]{d} N(0, 1)$. The number of lags were chosen to minimize the BIC criterion. The time period is from 2007:1 to 2019:4.
 ***, **, *, denote 1%, 5%, 10% statistical significance respectively.

Is There an Optimal Level of Leverage?

The Case of Banks and Non-Bank Institutions in Europe

March 9, 2024

Internet Appendix

Appendix A Measuring Systemic Risk

Over the last decade, several global systemic risk measures have been proposed (see Benoit et al., 2017) accounting for specific sources such as contagion, bank runs or liquidity crises. The Marginal Expected Shortfall (*MES*) of Acharya et al. (2017), the *SRISK* of Brownlees & Engle (2016), and the $\Delta CoVaR$ of Adrian & Brunnermeier (2016) are the most central measures in the systemic risk literature (Zhang et al., 2015; Benoit et al., 2017; Dićpinigaitienė & Novickytė, 2018; Grundke & Tuchscherer, 2019). In this section, we briefly describe the three measures of systemic risk $\Delta CoVaR$ (*Section A.1*), *MES* (*Section A.2*), and *SRISK* (*Section A.3*).

A.1 $\Delta CoVaR$

The CoVaR is an indicator of systemic risk defined as the Value at Risk (VaR) of the financial system as a whole, conditional on another financial institution, exceeding its specific VaR. VaR is the threshold loss that will not be exceeded at a given level of confidence. The $CoVaR_q^{system|C(X^i)}$ is defined by the q -th quantile of the conditional probability distribution:

$$Prob(X^{system|C(X^i)} \leq CoVaR_q^{system|C(X^i)}) = q\% \quad (10)$$

where X^i is the market-valued asset return of institution i , and X^{system} is the return of the financial system, computed as the average of the X^i 's weighted by the lagged market value assets of the institutions. Adrian & Brunnermeier (2016) measure the contribution of each financial institution to systemic risk by the $\Delta CoVaR$, namely the difference between $CoVaR$ conditional on the institution being in distress and $CoVaR$ in the median state of the institution. Formally, the $\Delta CoVaR_q^i$, i.e. the contribution to systemic risk of institution i during the q quartile, is defined as follows:

$$\Delta CoVaR_q^i = CoVaR_q^i - CoVaR_{50}^i = \hat{\beta}_q^i (VaR_q^i - VaR_{50}^i) \quad (11)$$

where the q is set to be 5%, so that $CoVaR^i$ identifies the system losses predicted on the 5% loss of financial institution i , while $\Delta CoVaR^i$ identifies the deterioration in the system

losses, when the financial institution i moves from its median state to its 5% worst scenario. VaRs and CoVaRs estimations are obtained using quantile regressions (q) (Koenker & Bassett, 1978). To estimate the time-varying $VaR_{q,t}^i$ and $CoVaR_{q,t}^i$, we include a set of state variables such as: *VSTOXX VOLATILITY INDEX*: a measure of anticipated stock market volatility for the euro area; *Yield slope*, the first difference of the French yield slope (5-year minus 3-month) on government bonds; *Liquidity Spread*, the difference between the 3-month Sterling Overnight Interbank Average Rate (SONIA) and the 3-month UK T-bill yield; *FTSE Returns*, the returns of FTSE European stock index; *Credit Spread*, the difference between Baa corporate bonds and the 10-year German government bond; *T-Bill change*, the first difference of the French 3-month interest rate. Table A1 reports the correlation matrix between $\Delta CoVaR$ and the full set of state variables, while Table A2 reports the summary statistics for the state variables.

Table A1: Correlation matrix among state variables. Dependent variable $\Delta CoVaR$.

	$\Delta CoVaR_{i,t}$	VSTOXX $_{t-1}$	Yield slope $_{t-1}$	Liquidity spread $_{t-1}$	FTSE Returns $_{t-1}$	Credit Spread $_{t-1}$	T-Bill change $_{t-1}$
$\Delta CoVaR_{i,t}$	1						
VSTOXX $_{t-1}$	0.0157*	1					
Yield slope $_{t-1}$	0.0892*	-0.0200*	1				
Liquidity spread $_{t-1}$	0.0592*	-0.0233*	-0.0185*	1			
FTSE Returns $_{t-1}$	-0.0279*	-0.7267*	0.0404*	0.0372*	1		
Credit Spread $_{t-1}$	0.1958*	-0.0607*	0.4512*	0.2587*	0.0150*	1	
T-Bill change $_{t-1}$	-0.1101*	0.0258*	-0.1682*	-0.4079*	0.0209*	-0.5375*	1

The table reports the correlations among state variables on weekly data from 2006 to 2019. The state variables are: *VSTOXX VOLATILITY INDEX*: is a measure of anticipated stock market volatility for the euro area and it is calculated on the basis of option prices and could, as a rough approximation, be interpreted as investors' expectations for the volatility of daily returns on the Dow Jones EURO STOXX 50 index over the next 30 calendar days; *Yield slope*: the first difference of the French yield slope (5-year minus 3-month) on government bonds; *Liquidity Spread*: is the difference between the 3-month Sterling OverNight Interbank Average Rate (SONIA) and the 3-month UK T-bill yield; *FTSE Returns*: is the returns of FTSE European stock index; *Credit Spread*: the difference between Baa corporate bonds and the 10-year German government bond *T-Bill change*: the first difference of the French 3-month interest rate. * denotes the statistical significance at 5% level.

Table A2: State Variables - Summary statistics.

	VSTOXX	Yield slope	Liquidity Spread	FTSE Returns	Credit Spread	T-Bill change
Mean	0.009	0.792	0.048	0.001	1.801	-0.004
Median	-0.003	0.595	0.021	0.003	1.465	0.000
Minimum	-0.489	-0.405	-0.348	-0.222	0.599	-0.336
Maximum	0.978	2.486	1.784	0.134	6.041	0.197
Std. Dev.	0.145	0.636	0.144	0.026	1.083	0.043
Skewness	1.406	0.778	3.557	-0.992	1.915	-2.857
Kurtosis	9.373	2.629	36.131	12.935	6.534	22.936

Summary statistics of the state variables: *VSTOXX VOLATILITY INDEX*: is a measure of anticipated stock market volatility for the euro area and it is calculated on the basis of option prices and could, as a rough approximation, be interpreted as investors' expectations for the volatility of daily returns on the Dow Jones EURO STOXX 50 index over the next 30 calendar days; *Yield slope*: the first difference of the French yield slope (5-year minus 3-month) on government bonds; *Liquidity Spread*: is the difference between the 3-month Sterling Overnight Interbank Average Rate (SONIA) and the 3-month UK T-bill yield; *FTSE Returns*: is the returns of FTSE European stock index; *Credit Spread*: the difference between Baa corporate bonds and the 10-year German government bond *T-Bill change*: the first difference of the French 3-month interest rate.

A.2 Marginal Expected Shortfall

The Marginal Expected Shortfall (*MES*) of a financial institution is defined as the contribution of that institution to the Expected Shortfall (*ES*) of the system (Acharya et al., 2017). The *ES* of the system is defined as the expected value of the market return conditional to the event that the market return is lower than a certain threshold C with the market return defined as the weighted average of all financial institutions' returns:

$$ES_{m,t}(C) = \mathbb{E}_{t-1}(r_{m,t} | r_{m,t} < C) = \sum_{i=1}^N \omega_{i,t} \mathbb{E}_{t-1}(r_{i,t} | r_{m,t} < C) \quad (12)$$

where $r_{m,t} = \sum_{i=1}^N \omega_{i,t} r_{i,t}$, and $\omega_{i,t}$ is the market share or capitalization of financial institution i . To ensure comparability with the other measures of systemic risk, we set the threshold C at 5% level. The contribution of institution i to the System Expected Shortfall (the *MES* of institution i) is, therefore, defined as the partial derivative of the *ES* with respect to the weight of institution i :

$$MES_{i,t} = \frac{\partial ES_{m,t}(C)}{\partial \omega_{i,t}} = \mathbb{E}_{t-1}(r_{i,t} | r_{m,t} < C) \quad (13)$$

A.3 SRISK

The *SRISK* of Brownlees & Engle (2016) measures the expected capital shortage faced by a financial institution during a period of system distress when the market declines substantially:

$$SRISK_{i,t} = \max[0; \kappa(D_{i,t} + (1 - LRMES_{i,t}W_{i,t}) - (1 - LRMES_{i,t})W_{i,t}] \quad (14)$$

where κ is the minimum fraction of capital as a ratio of total assets that each financial institution needs to hold (κ is set equal to the prudential capital ratio of 8%), and $D_{i,t}$ and $W_{i,t}$ are the book value of its debt and the market value of its equity, respectively. *LRMES* is the long-run Marginal Expected Shortfall (the *MES* on a six-months horizon) computed using the non-simulation method to estimate the expected fractional loss of the financial intermediary in a crisis when the market composite indexes decline significantly in a six-months period:

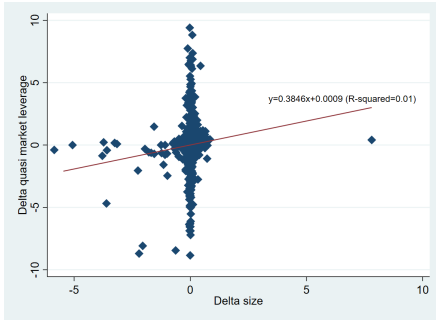
$$LRMES_{i,t} = 1 - \exp(\log(1 - d) * MES_{i,t}) \quad (15)$$

where d is the six-month crisis threshold for the market index decline and its default value is 40%. By defining leverage as $L_{i,t} = (D_{i,t} + W_{i,t})/W_{i,t}$, Equation (14) can be transformed into the following:

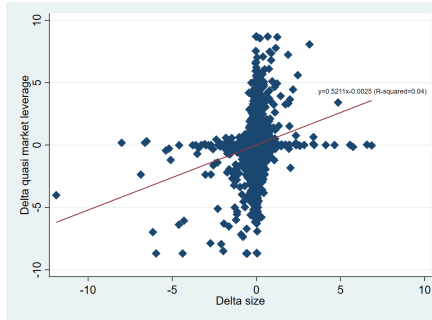
$$SRISK_{i,t} = \max[0; (\kappa L_{i,t} - 1 + (1 - \kappa)LRMES_{i,t})W_{i,t}, W_{i,t}[\kappa L_{i,t} + (1 - \kappa)LRMES_{i,t} - 1]] \quad (16)$$

Appendix B Additional figures

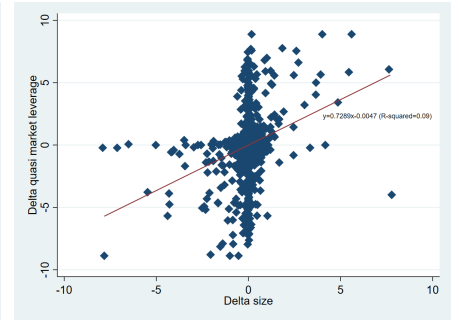
Figure B1: Relationship between leverage (market values first row, accounting values second row) and assets growth - TBs, FSs, REFs.



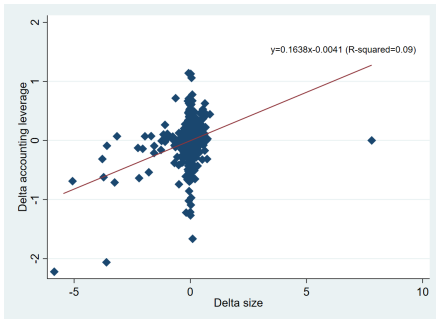
(a) Traditional Banks



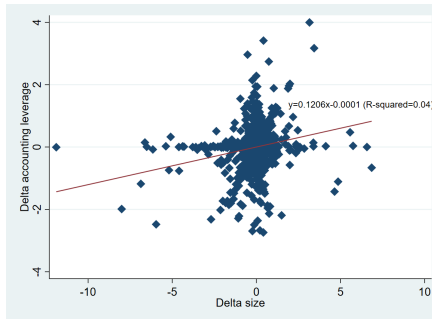
(c) Finance Services



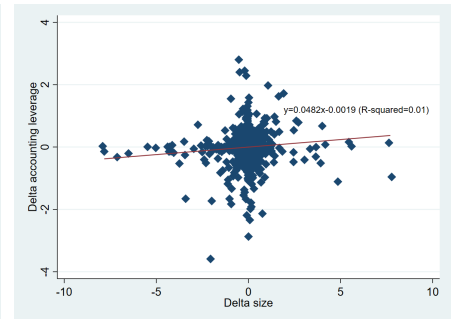
(e) Real Estate Fin. Serv.



(b) Traditional Banks

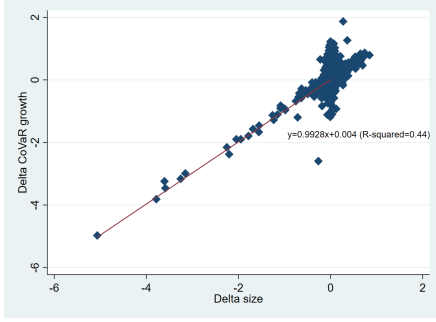


(d) Finance Services

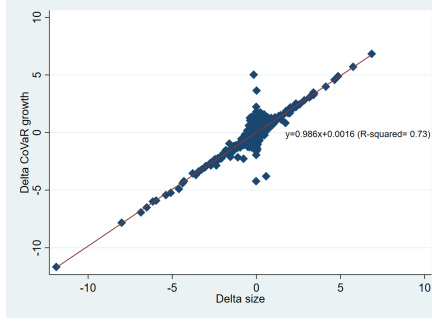


(f) Real Estate Fin. Serv.

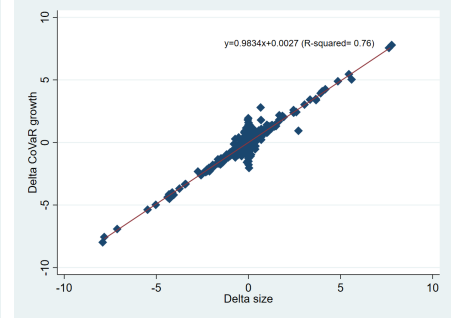
Figure B2: Relationship between systemic risk measures ($\Delta CoVaR$ first row, MES , $SRISK$ third row) and assets growth - TBs, FSs, REFs.



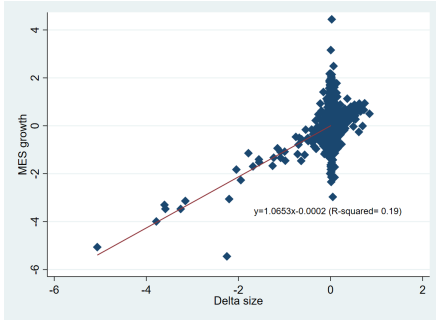
(a) Traditional Banks



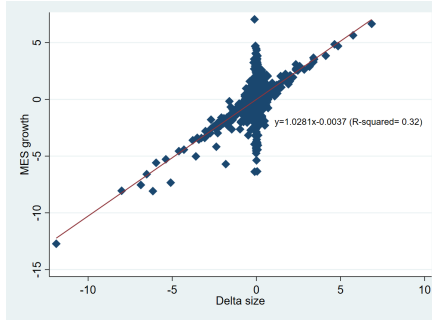
(d) Finance Services



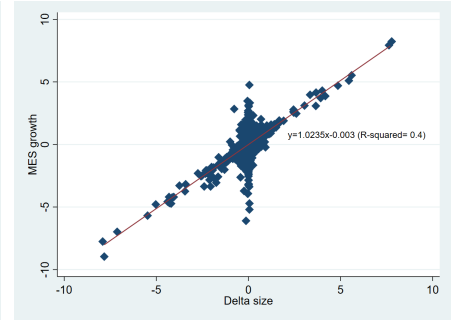
(g) Real Estate Fin. Serv.



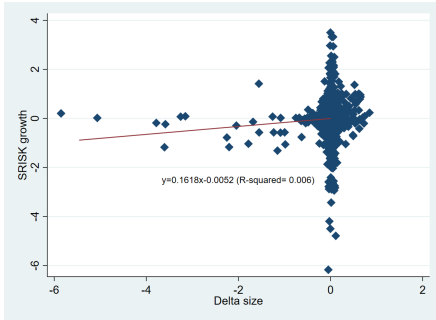
(b) Traditional Banks



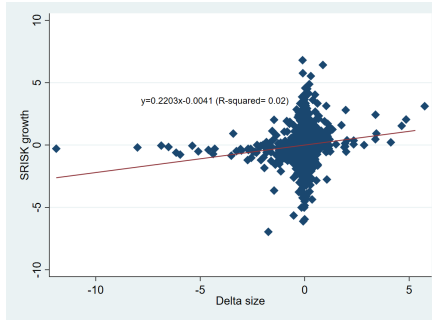
(e) Finance Services



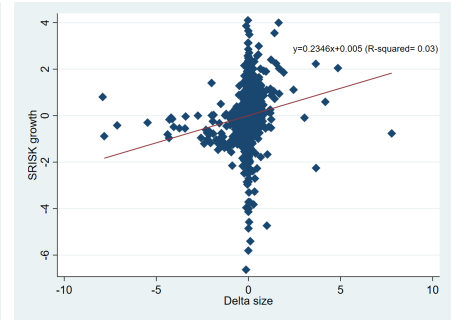
(h) Real Estate Fin. Serv.



(c) Traditional Banks



(f) Finance Services



(i) Real Estate Fin. Serv.

Appendix C List of Financial Institutions

Table C1: List of European Traditional Banks

Country	Traditional Banks
Austria	RAIFFEISEN BANK INTL.; OBERBANK; BANK FUR TIROL UND VBG.; BKS BANK; VOLKSBANK VBG.PARTN.; ERSTE GROUP BANK.
Belgium	KBC ANCORA; KBC GROUP; BANQUE NATIONALE DE BELGIQUE;
Bulgaria	CB CENTRAL COOP.BANK; CB BGN.AMER.CR.BK.
Croatia	KARLOVACKA BANKA; HRVATSKA POSTANSKA BANKA; ISTARSKA KREDITNA BANKA; KREDITNA BANKA ZAGREB; PRIVREDNA BANKA; ZAGREBACKA BANKA SER A.
Cyprus	HELLENIC BANK
Czechia	KOMERCNI BANKA
Denmark	LAN & SPAR BANK; FYNske BANK; GROENLANDSBANKEN; HVIDBJERG BANK; LOLLANDS BANK; MONS BANK; VESTJYSK BANK; SALLING BANK; SKJERN BANK; TOTALBANKEN; KREDITBANKEN; JUTLANDER BANK; SPAR NORD BANK; SYDBANK; DJURSLANDS BANK; NORDFYNS BANK; RINGKJOBING LANDBOBANK; DANSKE BANK; JYSKE BANK.
Estonia	TRIGON PROPERTY DEVELOPMENT
Finland	NORDEA BANK; ALANDSBANKEN A;
France	CRCAM DE NORMANDIE SEINE CCI PAR; CREDIT AGRICOLE; CRCAM ATLANTIQUE VENDEE; CARDE.CRAG.LRE. HAUTE- LOIRE PAR; CRCAM ILLE-VIL.CCI; CAISSE REG CRED AGRIC MUT TOURAIN POITOU; BNP PARIBAS; CR.AGRICOLE MORBIHAN; CRCAM NORD CCI; CREDIT AGR.TOULOUSE; CARDE.CAMU.APR.PAR; SOCIETE GENERALE; CREDIT AGR.ILE DE FRANCE; CAI.REGN.CR.AGRIC MUTUEL SUDRA PAR; CREDIT FONCIER DE MONACO; NATIXIS.
Germany	UMWELTBANK; HYDROTEC; AAREAL BANK; COMDIRECT BANK; QUIRIN PRIVATBK; ENERCITY PAR; MERKUR PRIVATBANK; COMMERZBANK; DEUTSCHE BANK.
Greece	ATTICA BANK; EUROBANK HOLDINGS; BANK OF PIRAEUS; ALPHA BANK; BANK OF GREECE; NATIONAL BK.OF GREECE.
Hungary	OTP BANK
Ireland	PERMANENT TSB GHG.; AIB GROUP; BANK OF IRELAND GROUP.
Italy	BANCA PPO.DI SONDRIO; BNC.DI DESIO E DELB.; UNIONE DI BANCHE ITALIAN; BCA.PICCOLO CDT.VALTCELL; BPER BANCA; BANCA GENERALI; BANCO DI SARDEGNA RSP; BANCA MONTE DEI PASCHI; BANCA PROFILO; BANCO BPM; UNICREDIT; INTESA SANPAOLO; BANCA FINNAT EURAMERICA; CREDITO EMILIANO.
Lithuania	SIAULIU BANKAS
Malta	FIMBANK; HSBC BANK MALTA; LOMBARD BANK; BANK OF VALLETTA.
Netherlands	ING GROEP; VAN LANSCHOT KEMPEN.
Poland	GETIN HOLDING; SANTANDER BANK POLSKA; PKO BANK; ING BANK SLASKI; MBANK; BANK MILLENNIUM; BANK POLSKA KASA OPIEKI; BANK OCHRONY SRODOWISKA; BANK HANDLOWY W WARSZAWIE.
Portugal	BANCO COMR.PORTUGUES 'R'
Romania	BRD GROUPE SOCIETE GL.; PATRIA BANK; BANCA TRANSILVANIA CLUJ.
Slovakia	TATRA BANKA; OTP BANKA SLOVENSKO; VSEOBECNA UVEROVA BANKA.
Spain	BANCO DE SABADELL; BANCO SANTANDER; BANKINTER 'R'; BBV.ARGENTARIA.
Sweden	SWEDBANK A; AVANZA BANK HOLDING; SKANDINAVISKA ENSKILDA BANKEN A; SVENSKA HANDELSBANKEN A.
United Kingdom	INVESTEC; HSBC HOLDINGS; LLOYDS BANKING GROUP; BARCLAYS; NATWEST GROUP; STANDARD CHARTERED; CLOSE BROTHERS GROUP; CARIBBEAN INVESTMENT.

Table C2: List of European Finance Services

Country	Finance Services
Austria	FRAUENTHAL HOLDING; UNTERNEHMENS INVEST; WIENER PRIVBK IM.INVT.; AB EFFECTENBETEILIGUNGEN.
Belgium	ACKERMANS & VAN HAAREN; GIMV; SOFINA; GBL NEW; COMPAGNIE DU BOIS SAUVAGE; TEX AF; BELUGA; PALMBOOMEN CULT. MIJ. MOPOLI PALMERAIES DE;
Bulgaria	HOLDING SVETA; INDUSTRIAL HLDG.BULGARIA; SEVERCOOP GAMZA HLDG; SYNERGON HOLDING; FAVORIT HOLD; DOVERIE OBEDINEN; RAZVITIE IND.HOLDING; CHERNOMORSKI HOLDING; POLDIN HOLDING; REPUBLICA HOLDING; BULGARIAN HOLDING CO.; TK-HOLD; INDUSTRIAL CAP.HLDG; DOBRUDZHA HOLDING; HOLDING COOP-YUG; BLG TRANSPORT HOLDING; HOLDING VARNA A; BULGAR-CZECH INVT.HLDG; YUTEX HOLDING; HOLDING CENTER; HD DUNAV; SILA HOLDING; ZENIT AGROHOLDING; HOLDING NOV VEK; BULVESTA HOLDING; ZLATEN LEV HOLDING; CHIMIMPORT.
Croatia	KARLOVACKA BANKA; HRVATSKA POSTANSKA BANKA; ISTARSKA KREDITNA BANKA; KREDITNA BANKA ZAGREB; PRIVREDNA BANKA; ZAGREBACKA BANKA SER A.
Cyprus	CPI HOLDINGS PUBLIC; A L PROCHOICE GROUP; LCP HOLDINGS AND INVESTMENT; ELLINAS FINANCE; SFS GROUP.
Czechia	RM-S HOLDING.
Denmark	STRATEGIC INVESTMENTS; NEWCAP HOLDING; LUXOR B.
Finland	PANOSTAJA; CAPMAN 'B; SIEVI CAPITAL ; EQ.
France	FINANCIERE HOCH BAINS; PRTE.INDUSTR.MRE; COURBET; BOURSE DIRECT; EUROLAND CORPORATE; COFIN.DE L AFR.DE L OUEST AFCN.; ALTUR INVEST; SC.FONFNC.ET DE PARTS.; VERNEUIL FINANCE; ADVENIS; ABC ARBITRAGE; UNION FINC.FRANC.; IDSUD; VIEL ET CIE; ALTAMIR; FORESTIERE EQUATORIALE; FIPP; EURAZEO; WENDEL; CAMBODGE (CIE DU); GROUPE IRD; FAUVET-GIREL; LEBON; ARTOIS INDFIN.DE L'ARTO; ROTHSCCHILD & CO; SOFRAGE MONCEY FINANCIERE.
Germany	KONSORTIUM; DEUTSCHE BOERSE; BAADER BANK; MAIER & PARTNER; SHAREHOLDERS VALUE BET; DLB-ANLAGESERVICE; MPC MUENCHMEYER CAP.K; HORUS; DNI BETEILIGUNGEN; SCHNIGGE CAPITAL MARKETS; CLERE; OEKOWORLD N PREFERENCE; INSTANT GROUP; FALKENSTEIN NEBENWERTE; GBK BETEILIGUNGEN; SYRAKUS HOLDING; SCHERZER & CO.; GRENKE N; PRIVATE ASSETS; EUWAX; SINO; HELIAD EQ PARTNERS; TRADE & VALUE; RM RHEINER MANAGEMENT; NAVIGATOR EQUITY; ERNST RUSS K; LLOYD FONDS K; HESSE NEWMAN CAPITAL; JDC GROUP; INDEPENDENT CAPITAL; BAVARIA INDUSTRIES GROUP; HOEVELRAT HOLDING; MBB; CGIFT; LENA BETEILIGUNGS; KIDS BRANDS HOUSE; AURELIUS SE & CO.KGAA; SCI; GENERAL TECHNOLOGIES; OVB HOLDING; TRINKAUS SECONDARY ZWEITAUSENDSECHS GMBH; AFENDIS PAYMENT; LANG & SCHWARZ WERTPAH; TRADEGATE; BLUE CAP; MIC K; MAX21; UET UNITED ELTECH; BAVARIA VET.CAP.& TRD.; DEUTSCHE BETEILIGUNGS; MLP; RED ROCK CAPITAL; EFFECTEN-SPIEGEL; VALUE-HOLDINGS; KST BETEILIGUNGS; SPARTA; BET.IM BALTIKUM; FORIS; VALUE MANAGEMENT & RESEARCH; FRITZ NOLS GLB.EQ.SVS; PEH WERTPAPIER; VESTCORP; SM WIRTSCHAFTSBERATUNGS; U C A; MWB FAIRTRADE WPHDLSBANK; SINO GERMAN UNITED K; SLEEPZ K; HSBC TRINKAUS & BURKHD.; ALLERTHAL-WERKE; ADCAPITAL; HEIDELBERGER BETEILIGUNGSHOLDING K; POMM.PR.VZ.ZUCKSIE.; GXP GERMAN PROPERTIES; GOLD-ZACK; DEUTSCHE BALATON K; BERLINER EFFTG; VALORA EFFEKTEN HANDEL; WUESTENROT & WUERTT; DT.EFF.U.D.WCH.- BTGU.
Greece	HELLENIC EXCHANGES HDG; MARFIN INV.G.PHDG.
Hungary	FORRAS FORRAS/T; TAKAREK MORTGAGE BK; EHEP SHARE.
Italy	DEA CAPITAL; AZIMUT HOLDING; BANCA IFIS; BANCA INTERMOBILIARE; TAMBURI INV.PARTNERS; GEQUITY; IVENTURE GROUP; MEDIOBANCA BC.FIN; MITTEL; TITANMET; ITALMOBILIARE.
Luxembourg	CEDEC; LUXEMPART; BRAIT; MIDILUX HOLDINGS; GEFINOR; BLUE MARLIN HOLDINGS.
Malta	GLOBALCAPITAL
Netherlands	VALUES; HAL TRUST.
Poland	MCI CAPITAL; CAPITAL PARTNERS; IDM; ALTA; TECH INVEST GROUP; IMPERA CAP. ALTERNATYWNA SPOLKA; RUBICON PARTNERS NFI; MAGNA POLONIA; MDI ENERGIA; BEST.
Romania	NORD SA; LACTATE NATURA; COMALEX.
Slovakia	PRVA STRATEGICKA; DRUHA STRATEGICKA; GARFIN HOLDING I; VIPO.
Slovenia	MI FINANCNA DRUZBA; KD; HRAM HOLDING; NIKA REDNE.
Spain	BOLSAS Y MERCADOS ESPAÑOLES; ALANTRA PARTNERS; MOBILIARIA MONESA; CORP FIN ALBA SA.
Sweden	INTRUM AB; CATELLA B; BURE EQUITY; ORESUND INVESTMENT; KINNEVIK B; INVESTOR B; LATOUR INVESTMENT B; RATOS B; NISCHER PROPERTIES; TRACTION B; INDUSTRIVARDEN A.
United Kingdom	FIRST PROPERTY GROUP; HIGHWAY CAPITAL; TWO SHIELDS INVS.; INTERMEDIATE CAPITAL GP; BREWIN DOLPHIN; MAN GROUP; METAL TIGER; MARECHALE CAPITAL; GLEDHOW INVS; VOLVERE; ASIMILAR GROUP; CATENA GROUP; IP GROUP; TAVISTOCK INVESTMENTS; CLEAR LEISURE; FISKE; BEGBIES TRAYNOR GP; SIGMA CAPITAL GROUP; CRAVEN HOUSE CAPITAL; FRENKEL TOPPING GROUP; BLUE STAR CAPITAL; LONDON STOCK EX.GROUP; W H IRELAND GROUP; STARVEST; MINERAL & FINL.INVS; JARVIS SECURITIES; KINGSWOOD HOLDINGS; BROOKS MACDONALD GROUP; IG GROUP HOLDINGS; LIVERMORE; IRF EUROPEAN FIN.INVS. (DI); MATTIOLI WOODS; B P MARSH & PARTNERS; CITY OF LONDON INV.GP.; H&T GROUP; ARDEN PARTNERS; STANDARD LIFE ABERDEEN; 1PM; ASHMORE GROUP; CENKOS SECURITIES; TP ICAP; SAROSSA (OTC); LIONTRUST ASSET MAN.; PCF GROUP; NUMIS; WALKER CRIPS GROUP; IMPAX ASTMGMT.GROUP; WORLDSEC; S & U; SCHROEDERS; PROVIDENT FINANCIAL; RATHBONE BROTHERS; PARAGON BANKING GROUP; RIVERFORT GLB.OPPS. ORD SHS; WESTERN SELECTION; CHARLES STANLEY GROUP; LONDON FIN.& INV.GP; APPRECIATE GROUP; CITY OF LONDON GROUP; ARBUTHNOT BANKING GROUP; GLI FINANCE.

Table C3: List of European Real Estate Finance Services

Country	Real Estate Finance Services
Austria	ATRIUM EUROPEAN; ATHOS IMMOBILIEN; SPARKASSEN IMMOBIL; CA IMMOBILIEN AG; IMMOFINANZ AG; UBM DEVELOPMENT.
Belgium	ASSOCIATION DES CO; IEP INVEST NV; BASILIX; BELRECA; CIE FINANCIERE DE NEUFCEUR; ACCENTIS; ATENOR; COMPAGNIE IMMOBILIERE DE BELGIQUE; INTERLOGIC REAL ESTATE AD SOFIA; INTERLOGIC LEASING SA.
Cyprus	PHILOKTIMATI; K & G COMPLEX; WOOLWORTH(CYPRUS); PANDORA INVS.
Denmark	BLUE VISION; AGAT EJENDOMME; PARK STREET NORDICOM A; JEUDAN; VICTORIA PROPERTIES.
Estonia	TRIGON PROPERTY DEVELOPMENT.
Finland	INVESTORS HOUSE; CITYCON.
France	IMMOB.PARIS DE LA PERLE LIMITED; ADOMOS; STRADIM-ESPACE FIN.; NEXITY; CAPELLI; BAUD MAISON LIMITED; CBO TERRITORIA; BASSAC; CROSSWOOD; CARPINIENNE PARTS; COURTOIS; FIDUCIAL REAL ESTATE; PATRIMOINE ET COMMERCE; ARTEA; SOFIBUS PATRIMOINE; FONCIERE VOLTA; NATIONAL PROPRIETE IMM; COMPAGNIE FONCIERE ILE; LA FONCIERE VERTE; ALTAREIT; FIEBM; GALIMMO.
Germany	UNIPROF RLST.HLDG; INVESTUNITY PREF.; DIC ASSET; DEUTSCHE EUROSHOP; VERIANOS REAL ESTATE; RCM BETEILIGUNGS; SALVATOR GRUNDBESITZ GSH. 9.5%; RIM; VIB VERMOEGEN N; HAEMATO; PATRIZIA; DEUTSCHE WOHNEN BR.SHS; GATEWAY REAL ESTATE; PRIMAG; RIPAG; DEMIRE REAL ESTATE; ENSOPELLA AG; GWB IMMOBILIEN; DT.GRUNDSTUCKSAUKTIONEN; TTL BETEILIGUNGS- UND GRUNDBESITZ; WESTGRUND; YMOS; BASTFASERKONTOR; BBI BURGLICH.BRAUH.IM.; GAG IMMOBILIEN PREF.; OAB OSBK ANLG.UND BETS.; SEDLMAYR GRUND UND IMMOBILIEN; WKM TERRAIN & BETS.; WCM BETS.-UND GRUNBSZ.; TAG IMMOBILIEN; GTG DNSTGPE.; AGIV REAL ESTATE; AGROB IMMOBILIEN; ADLER REAL ESTATE; HASEN-IMMOBILIEN; DEUTSCHE REAL ESTATE; AAA AG ALLGEMEINE ANLAG.; COLONIA REAL ESTATE.
Greece	KEKROPS; REDS REAL ESTATE DEVELOPMENT; ALPHA ASTIKA AKINITA; LAMDA DEVELOPMENT.
Hungary	GRAPHISOFT PARK SE SHARE.
Italy	CIA; GABETTI PROPERTY SLTN.; NOVA RE; RISANAMENTO; BRIOSCHI SVILUPPO IMMBL; RESTART.
Latvia	RIGAS AUTOELEKTROAPARATU; VEF;
Lithuania	INVALIDA INVL
Luxembourg	CPI PROPERTY GROUP
Malta	PLAZA CENTRES
Netherlands	KARDAN N V -L; ARCONA PROPERTY FUND; PLAZA CENTERS; BEVER HOLDING.
Poland	MCI CAPITAL; CAPITAL PARTNERS; IDM; ALTA; VICTORIA AOPR.CENTRE; BEST; IMPERA CAP. ALTERNATYWNA SPOLKA; RUBICON PARTNERS NFI; MAGNA POLONIA; MDI ENERGIA.
Portugal	SONAGI LIMITED DATA
Romania	UNIREA SHOPPING CENTER; PRACTIC BUCURESTI; IMOTRUST; COCOR; CONECT BUSINESS PARK; PRIMCOM BUCURESTI; STDC.IN TSB.
Spain	INMOBILIARIA DEL SUR LIMITED DATA; AYCO GRUPO INMOBILIARIO; RENTA CORPN.REAL ESTATE; QUABIT INMOBILIARIA; NYESA VALORES; URBAS GUADAHERRA; UNION CATALANA DVL.; CEVASA; MONTEBALITO.
Sweden	HEBA FASTIGHETS B; ATRIUM LJUNGBERG B; KLOVERN A; FASTIGHETS BALDER B; AMASTEN FASTIGHETS; WALLENSTAM 'B'; WILHBORGS FASTIGHETER; FAST PARTNER A; AMHULT 2 B; CATENA; DIOS FASTIGHETER; FABEGE; SAGAX; KUNGSLEDEN; JM; LUNDBERGFORETAGEN B; CASTELLUM; COREM PROPERTY GROUP A; HUFVUDSTADEN A.
United Kingdom	URBAN CIVIC; CLS HOLDINGS; CALEDONIAN TRUST; FORMATION GROUP; CONYGAR INVESTMENT CO.; SEC PROP DEVELOPMENTS; LOK'N STORE GROUP; PALACE CAPITAL; ADAMS PLC; RAVEN PROPERTY GROUP LIMITED; HARWORTH GROUP; HML HOLDINGS; ALPHA REAL TRUST; LSL PROPERTY SERVICES; PIRES INVESTMENTS; U AND I GROUP; ST MODWEN PROPS; FLETCHER KING; CARDIFF PROPERTY; HELICAL REIT; PANTHER SECURITIES; WYNNSTAY PROPERTIES; LONDON & ASSOCS.PROPS; MOUNTVIEW ESTATES; BOOT (HENRY); GRAINGER; SAVILLS.